TRAIL AND CAMPSITE EROSION SURVEY FOR GREAT SMOKY MOUNTAINS NATIONAL PARK

Part III: The Condition of Trails

RESEARCH/RESOURCES MANAGEMENT REPORT No. 16

U.S. DEPARTMENT OF THE INTERIOR
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UPLANDS FIELD RESEARCH LABORATORY
GREAT SMOKY MOUNTAINS NATIONAL PARK
TWIN CREEKS AREA
GATLINBURG, TENNESSEE 37738

TRAIL AND CAMPSITE EROSION SURVEY

FOR

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Susan Power Bratton
Matthew G. Hickler
James H. Graves

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U.S. Department of the Interior
National Park Service
Southeast Regional Office
Natural Science and Research Division
Uplands Field Research Laboratory
Great Smoky Mountains National Park
Gatlinburg, Tennessee 37738

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THE ANALYSIS OF THE TRAILS DATA

The trails data have been largely analyzed by averaging samples. No effort was made to correct the differences in mileage between samples, since it would have added little to the accuracy of the averages. Most of the samples were 1/3 mile apart.

As explained in the methods section, Part I, of this report, several new variables have been created in the process of analyzing the data. Tread width is the sum of bare soil and bare rock. This is not "tread width" as defined in the maintenance standards for the park, which is the same as total width reported here. Computer erosion and the width ratings are explained in the methods section.

A few adjustments were made for individual differences in sampling. The most important of these was the conversion of the presence/absence figures for water erosion for LeConte, Cosby, and the eastern half of the Appalachian Trail to a percentage figure (the average occurrence x 100). These converted variables are marked with an asterisk.

Notice that, in most cases, totals are shown for all trails, which include jeep roads and manways (unmaintained trails), and for "maintained trails only," which do not include jeep roads and manways. A jeep trail was often difficult to identify, since many horse trails have been maintained to jeep width. This issue was further confused by the closure of many trails to jeeps during survey. Most of the trails classed as jeep roads in this survey are no longer used by vehicles.

The "maintained trails only" data are probably the best for assessing problems which are largely due to visitor impact rather than to physical factors. The intensely maintained and surfaced jeep roads show less wear from visitor use. Average tread width and depth of an unsurfaced trail tell a fair amount about its condition and the type of maintenance required.

In comparing erosion, overall, and computer erosion ratings, note that sections 6 and 7 tended to be overrated in the field, and the computer ratings are almost certainly the best. The computer tended to lower the ratings for section 8, but this is largely due to the amount of bank erosion and slumping rather than to high use or surface erosion.

DIFFERENCES BETWEEN STATES

Since the trails are maintained on a district basis, the first patterns to examine are those that compare the two states and the overall averages for the park. Table 1 shows the average widths and depths. The Appalachian Trail is narrower than the average total width for the park but has the greatest proportion of tread. When one considers only maintained trails (those excluding jeep roads and manways), the greatest average tread width is found on the Appalachian Trail. The Appalachian Trail is also 3.4 centimeters deeper than the total park average.

The total trail width is greater on the North Carolina side of the park, but the average tread width and the average depth are greater in Tennessee.

Table 2 shows the various erosion classes by state. Computer erosion ratings are perhaps the fairest to use since they compensate for investigator differences. Tennessee has slightly more poor samples than North Carolina. The Appalachian Trail is substantially poorer, with only 7 percent of the samples rated Class 1 and 29 percent rated 4 or 5.

Table 1 . Average Trail Widths and Depths for Tennessee, North Carolina and the Whole Park

All Roads and Trails	N	Width cm	Tread Width cm	% Tread	Litter Width cm	Depth cm
AT	198	126.2	101.3	80%	17.6	7.4
Tn.	1322	169.7	115.9	68%	42.6	4.8
N.C.	1330	183.9	92.9	51%	34.7	3.2
All	2850	173.3	104.2	60%	37.2	4.3
Maintained Trails Only						
AT	169	121.0	98.2	81%	14.6	7.9
Tn.	847	137.0	94.8	69%	35.3	5.1
N.C.	840	136.0	75.6	56%	26.0	3.2
All	1856	135.1	86.4	64%	29.2	4.5

Table 2 . Distribution of Erosion Classes by State and for the whole Park.

Erosion Sections	Class 1	2	3	4	5
AT	7	51	57	44	17
	4%	29%	32%	25%	10%
Tn.	249	474	463	119	17
	19%	36%	35%	9%	1%
N.C.	326	427	352	178	47
	25%	32%	26%	13%	4%
All Park	582	952	872	341	81
	21%	34%	31%	12%	3%
Overall Sections					
AT	1	35	81	42	17
	1%	20%	46%	24%	10%
Tn.	227	496	434	152	30
	17%	38%	33%	11%	2%
N.C.	351	463	310	152	54
	26%	35%	23%	11%	4%
All Park	579	994	825	346	101
	20%	35%	29%	12%	4%

Table 2 . Distribution of Erosion Classes by State and for the whole Park - Cont.

Computer Erosion Sections	Class 1	2	3	4	5
AT	13	55	57	19	32
	7%	31%	32%	11%	18%
Tn.	179	436	403	115	189
	14%	33%	30%	9%	14%
N.C.	240	515	356	91	128
	18%	39%	27%	7%	10%
All Park	432	1006	816	225	347
	15%	36%	29%	8%	12%

Overall ratings listed the walking surface as fair to poor for 80 percent of the Appalachian Trail.

Table 3 shows individual types of erosion by state. Tennessee again tends to be slightly poorer than North Carolina, with more water erosion, rut, rock, horse plow, and roots for all trails. Looking at maintained trails only, the differences are somewhat less, but bare rock and exposed roots are still more prevalent on the Tennessee side. The Appalachian Trail is, of course, generally poorer than either, only falling below the all-park averages for bank erosion and vehicle rut.

On an all-park basis, water erosion is, by far, the most important problem. An estimated 15 percent of the trail surface in the park is noticeably eroded by water. About 5 percent of the trail surface was muddy, 9 percent was rutted (to 10 centimeters or more) and 4 percent was horse plowed; 15 percent of the surface was bare rock and 9 percent had exposed roots. Vehicle rut was a relatively minor problem, with less than 1 percent of the trail surface affected. Since water erosion is integrally related to the amount of bare rock and rut, control of water in trails should probably take precedence over other possible changes in maintenance, such as drainage of mudholes.

Table 3 . Average Erosion Measurements for Tennessee, North Carolina and the whole Park.

All Roads and Trails	N	PERCENT Water Erosion	Mud	Rut	Horse Plow	Foot Plow	Vehicle Rut	Rock	Roots	Bank Erosion
AT	198	30.6	11.5	11.9	5.8	4.2	.2	25.9	11.8	5.3
Tn.	1322	17.3	5.7	12.1	7.5	3.2	1.5	16.2	9.0	6.7
N.C.	1330	11.6	5.7	6.3	4.9	1.6	1.0	9.7	5.3	5.7
All	2850	15.1	6.0	9.2	6.1	2.5	1.1	13.6	7.3	6.0
Maintained Trails Only										
AT	169	28.7	13.4	13.6	6.7	4.8	.0	25.4	12.3	3.3
Tn.	847	14.8	4.5	9.4	2.8	.5	.7	17.3	10.3	7.5
N.C.	840	11.8	4.4	7.2	5.3	1.5	.1	9.6	6.2	5.2
All	1856	15.3	5.2	8.8	4.3	1.4	.4	15.0	8.8	3.3

From the tread width and depth data, there appears to be more wear on the Appalachian Trail and on the Tennessee side of the park the trails are closer to their carrying capacities than the trails in North Carolina. The trails on the North Carolina side tend to have a greater total width versus a narrower tread width, which implies that some of them may be maintained to a slightly greater width than necessary.

With the average tread width of the trails (excluding jeep roads) approaching 90 centimeters, it may be difficult to keep total trail width to the 120 centimeters (4-foot) standard. Trails that have 120 or 130 centimeters of tread may need to be maintained to 150 or 180 centimeters. This is close to jeep width but may be preferable in the case of heavily used horse and foot trails.

Table 4 shows the distribution of trail width by present trail maintenance standards. Only 11 percent of width measurements taken fell into the "foot trail only" class. Less than half (40 percent) of the samples fit the present standards for foot and horse trails. A high 34 percent were not classed as jeep roads but were wider than 130 centimeters, usually due to water erosion, heavy use, or past maintenance practices.

Table 4. Frequency of Maintenance Width Classes by Section.

Section	Foot Trail 60 cm	Foot - Horse 130 cm	Jeep Trails	Other
1	26 (15%)	69 (39%)	24 (13%)	57 (32%)
2	5 (4%)	36 (29%)	57 (46%)	25 (20%)
3	17 (8%)	38 (29%)	62 (39%)	74 (39%)
4	9 (8%)	37 (33%)	38 (34%)	28 (25%)
5	26 (14%)	44 (24%)	29 (15%)	84 (45%)
6 (No Manways)	15 (4%)	83 (24%)	74 (21%)	165 (49%)
7 (No Manways)	24 (17%)	39 (28%)	32 (23%)	44 (32%)
8	14 (10%)	70 (52%)	26 (19%)	23 (17%)
9	2 (3%)	12 (17%)	21 (31%)	32 (48%)
10	37 (17%)	53 (24%)	59 (27%)	68 (31%)
11	10 (6%)	62 (35%)	61 (34%)	44 (25%)
12	73 (26%)	80 (28%)	78 (28%)	50 (18%)
13	11 (8%)	54 (38%)	45 (32%)	31 (22%)
14	13 (13%)	28 (27%)	24 (23%)	36 (36%)
15	4 (2%)	63 (28%)	70 (31%)	92 (40%)
16	1 (1%)	28 (23%)	23 (20%)	65 (55%)
Total	287 (11%)	796 (29%)	723 (27%)	918 (34%)

DIFFERENCES BY SECTION

Trail condition varies tremendously from area to area in the park. Tables 5 through 14 compare major trail variables by section (Figure 1).

In terms of tread width (Tables 5 and 6), Cades Cove (3), LeConte (6), Big Creek (16), Elkmont (5), the Appalachian Trail (1), and Smokemont (13) are, by far, the worst sections. In terms of depth, LeConte (6) and the Appalachian Trail (1) are particularly rutted, followed by Cataloochee (15), Forney Creek (11), Cades Cove (3), and Cosby (7). The sections which have the best tread-to-total width ratios are Twenty Mile (9), Deep Creek (12), the Boundary Trail (8), and Forney Creek (10). Abrams Creek (2) has a relatively low ratio, as do Forney Creek (11) and Cataloochee (15), but the latter two are well rutted, partially due to horse use.

Tables 7, 8, and 9 show the importance of mud, water, and other types of erosion. A poor section may have more than 10 times the problem of a good section. Sections 1, 3, 6, 7, 11, 14, 15, and 16 all have over 10 percent of the trail surface showing water erosion. Sections 1, 3, 6, 14, and 15 have greater than

5 percent mud. Rut is over 10 percent in sections 1, 6, and 7, and bare rock is over 10 percent in sections 1, 3, 6, 7, 11, 13, 14, and 16. Bare roots are common in sections 1, 6, 7, and 14, all of which contain substantial areas of spruce-fir forest. Bank erosion is nowhere a particularly severe problem but is most frequent in section 8, otherwise a very good section. Sections 1, the Appalachian Trail, and 15, Cataloochee, have the greatest areas of mudholes, and sections 2, 5, and 1 have the greatest areas of large washouts (eroded areas) per trail sample.

The frequency of erosion, overall, and computer erosion classes by section and the summary table are shown in Tables 10 through 13. Average ratings of less than 3 are poor (Table 13). The worst sections, on the average, are the Appalachian Trail (1), LeConte (6), and Cades Cove (3). Sections with ratings of about 2.6 or below are having substantial problems with erosion. This includes 7, 14, 15, and 16. Sections in the 2.3 to 2.6 range are fair, including 5, 10, and 13. The remainder are good to excellent, on the average, including 2, 4, 8, 9, and 12. The best areas, then, are Abrams Creek, Tremont, Twenty Mile, and Deep Creek. All of these could absorb more hiker traffic.

Table 5 . Mean Width and Depth Values by Section - All Trails and Roads.

Trail Section	N	Width cm	Tread Width cm	% Tread	Rock cm	Soil cm	Litter cm	Depth cm
1	198	126	101	80%	29	72	18	7.4
2	123	220	129	59%	37	91	58	2.4
3	191	203	164	81%	14	150	27	5.0
4	112	192	118	61%	10	108	57	2.3
5	183	177	122	69%	19	103	29	2.9
6	425	155	113	73%	38	75	41	7.7
7	155	146	110	75%	59	52	38	4.9
8	133	122	40	33%	1	39	66	2.3
9	67	215	87	40%	2	85	76	1.5
10	217	1953	75	39%	5	70	39	2.1
11	177	203	104	51%	9	95	30	4.2
12	281	161	84	52%	12	72	45	1.2
13	141	180	149	83%	8	140	19	3.3
14	101	146	108	74%	5	103	24	1.0*
15	229	186	109	59%	6	103	29	7.7
16	117	205	129	63%	10	117	25	2.5

*Some depths in this section were undermeasured.

Table 6. Mean Width and Depths by Section - Maintained Trails Only.

Trail Section	N	Width cm	Tread Width cm	% Tread	Rock cm	Soil	Litter	Depth
1	169	121	98	81%	26	72	15	7.9
2	64	117	66	56%	4	62	41	2.2
3	116	160	129	81%	14	116	23	5.0
4	73	135	80	59%	12	67	55	3.4
5	120	150	108	72%	18	90	27	2.8
6	262	145	112	77%	30	81	32	8.5
7	105	118	80	68%	27	53	38	4.8
8	107	108	43	40%	1	42	46	2.3
9	46	157	59	38%	4	57	28	1.3
10	98	179	77	43%	4	73	39	2.8
11	74	131	73	56%	9	64	20	5.1
12	167	97	43	44%	0	43	39	1.0
13	91	120	97	81%	3	94	10	4.0
14	70	124	89	72%	5	81	17	1.0*
15	159	151	84	56%	1	83	28	5.6
16	94	161	100	62%	11	89	17	2.8

*Some depths in this section were undermeasured.

Table 7. Average Percent Occurrence of Major Types of Erosion for All Trails and Roads by Section

Trail Section	Water Erosion	Mud	Rut	Rock	Roots	Side
1	19.7*	11.5	11.9	25.9	11.8	5.3
2	8.0	.6	2.7	2.8	.7	2.8
3	13.2	10.6	9.8	14.0	5.0	9.3
4	1.8	.7	.7	3.9	3.6	2.0
5	8.1	3.4	7.9	8.8	8.3	7.8
6	34.1*	9.0	19.4	30.3	15.4	6.3
7	18.1*	1.9	13.8	19.3	14.2	6.9
8	3.2	4.1	6.8	4.1	1.1	10.2
9	8.9	.6	2.1	3.6	.3	.8
10	6.6	2.6	4.5	6.6	3.9	6.3
11	15.5	5.0	9.2	13.0	4.7	7.0
12	6.8	3.2	2.9	3.8	3.4	4.5
13	11.1	1.4	8.5	11.0	4.7	6.7
14	13.8	8.2	5.6	15.4	16.9	7.6
15	10.9	15.0	9.8	8.6	4.2	2.6
16	19.5	2.9	2.9	17.5	5.7	6.2

*From presence absence data

Table 8. Average Percent Accruance Major Types of Erosion for Maintained Trails Only By Section.

Trail Section	Water Erosion	Mud	Rut	Rock	Roots	Side
1	22.0*	13.4	13.6	25.4	12.3	3.3
2	.8	.6	.0	2.0	1.3	1.7
3	12.5	1.7	6.6	17.6	6.5	9.1
4	2.3	1.0	1.0	5.4	5.5	2.7
5	9.1	3.3	6.8	8.4	7.5	11.3
6	~29.0*	8.9	15.7	32.8	17.6	6.5
7	~19.0*	2.3	14.1	21.9	17.8	8.4
8	3.4	4.7	2.4	1.8	.8	9.5
9	7.0	.6	2.7	3.3	.4	1.2
10	10.5	3.7	5.9	6.2	5.7	9.4
11	19.0	2.6	12.5	14.7	6.9	6.5
12	4.9	3.2	2.4	3.1	5.0	1.6
13	11.0	1.9	11.3	11.0	5.7	7.8
14	9.6	1.7	3.7	14.1	15.0	7.9
15	10.7	11.5	12.1	7.9	4.7	2.6
16	23.2	3.3	3.0	19.4	6.9	7.2

*From presence absence data

Table 9 . Average Area of Mudholes and Eroded Areas by Section.

	All Roads and Trails		Maintained Trails Only	
Section	Mud m^2	Erosion m^2	Mud m^2	Erosion^2
1	15.6	9.6	18.1	11.2
2	3.4	12.6	4.5	10.0
3	1.8	5.5	2.1	4.2
4	4.9	3.9	6.5	5.2
5	9.0	13.4	3.3	12.4
6	3.2	6.4	4.0	9.9
7	.3	.0	.2	.0
8	.0	.0	.0	.0
9	3.0	0.0	4.3	.0
10	4.6	0.0	5.4	.0
11	9.4	.5	6.7	.8
12	8.1	9.5	6.6	5.4
13	5.1	3.1	7.6	2.6
14	7.7	.3	3.5	.5
15	17.7	.9	17.5	.0
16	6.5	.0	8.1	.0

Table 10. Frequency of Erosion Classes by Section.

Section	Class Percent 1	2	3	4	5
1	4	29	32	25	10
2	34	31	29	5	0
3	14	25	39	20	2
4	30	42	21	5	1
5	17	43	27	8	4
6	8	32	49	9	1
7	8	49	35	8	0
8	50	38	11	0	0
9	48	28	16	7	0
10	44	33	16	5	2
11	14	42	27	11	7
12	37	31	17	12	2
13	19	38	30	11	1
14	5	37	39	16	4
15	13	16	35	29	7
16	6	40	41	11	2

Table 11. Frequency of Overall Class by Section.

Section	Class 1	2	3	4	5
1	1	20	46	24	10
2	37	42	16	5	0
3	10	30	33	25	2
4	19	57	16	7	1
5	18	39	32	8	3
6	6	30	48	15	1
*	6	30	49	14	1
7	4	50	37	9	0
*	4	5	37	9	0
8	58	32	9	0	0
9	55	24	16	4	0
10	48	32	14	4	2
11	14	46	21	10	8
12	38	36	14	9	2
13	23	38	29	6	4
14	4	41	35	17	4
15	14	20	33	25	8
16	7	45	34	12	2

*With manways

Table 12. Frequency of Computer Erosion Class by Section.

Section	Class 1	2	3	4	5
1	7	31	32	11	18
2	25	43	21	2	7
3	6	36	29	6	21
4	16	54	26	3	1
5	12	39	29	5	15
6	8	22	36	14	20
*	4	25	37	14	20
7	8	34	36	13	10
*	5	34	39	12	9
8	38	26	21	7	8
9	19	48	22	7	3
10	22	42	27	2	8
11	14	42	23	7	12
12	36	35	17	5	7
13	13	47	28	5	8
14	5	41	38	10	7
15	12	24	34	14	15
16	3	46	32	4	15

*With manways

Table 13. Average Damage Rating by Section.

Trail Section	All Trails and Roads			Maintained Trails		
	Erosion	Overall	Computer	Erosion	Overall	Computer
1	3.04	3.15	2.95	3.20	3.28	3.00
2	2.05	1.89	2.24	1.70	1.66	1.78
3	2.71	2.77	3.01	2.84	2.84	3.03
4	2.04	2.14	2.18	2.14	2.23	2.20
5	2.38	2.39	2.73	2.23	2.27	2.69
6	2.64	2.73	3.15	2.73	2.81	3.15
7	2.43	2.51	2.83	2.50	2.60	2.89
8	1.61	1.50	2.20	1.52	1.42	1.98
9	1.83	1.70	2.27	1.63	1.45	2.15
10	1.88	1.81	2.31	2.05	1.92	2.66
11	2.55	2.53	2.61	2.60	2.60	2.63
12	2.11	2.00	2.12	1.96	1.85	1.86
13	2.37	2.28	2.48	2.40	2.32	2.46
14	2.77	2.76	2.73	2.61	2.61	2.48
15	3.00	2.93	2.95	2.88	2.80	2.90
16	2.62	2.56	2.82	2.71	2.66	2.95

HORSE DAMAGE AND VEHICLE RUT

Although horse damage, as a whole, is a less significant cause of erosion than uncontrolled water damage in the park it is an important source of problems in several sections. In Cataloochee (15), horse plow was more prevalent than water erosion (16.5 percent versus 10 percent) and is almost certainly responsible for the high percentage of mud in the area (15 percent--greatest for any section in the park). LeConte (16) and Cades Cove (3) also have fairly high percentages of horse plow (Table 14). The Appalachian Trail (1), Forney Creek (11), and Smokemont (13) have about 5 percent horse plow.

The impact of extensive horse use on some individual trails is shown in Table 15. Special problem trails, excluding those used almost exclusively by concessions, include the Cades Cove Loop to Rich Mountain, Rainbow Falls, Cataloochee Divide, and Double Gap.

It is important to note that the three sections with the most damage due to horses represent three of the four sections where commercial horse use is greatest--Mount LeConte, Cades Cove, and Cataloochee. (Smokemont is in slightly better condition.) Several of the most serious individual problem

Table 14. The Average Importance of Horse and Vehicle Damage by Section.

	All Trails and Roads				Maintained Trails Only			
Trail Section	% Mud	% Horse Plow	% Vehicle Rut	% Foot Plow	% Mud	% Horse Plow	% Vehicle Rut	% Foot Plow
1	11.5	5.8	.2	4.2	13.4	6.7	.0	4.9
2	.6	.6	1.4	.2	.6	.5	.01	.3
3	10.6	7.7	.03	2.3	1.7	6.5	.01	.5
4	.7	.0	.1	.2	1.0	.0	.0	.3
5	3.4	.0	.0	1.2	3.3	.0	.0	1.0
6	9.0	8.0	1.9	2.0	8.9	5.5	1.1	.5
7	1.9	.4	3.1	.1	.2	.3	2.7	.01
8	4.1	.6	3.4	.6	4.7	.8	.3	.8
9	.6	.0	2.4	.01	.6	.0	2.4	.02
10	2.7	.8	.8	.3	3.7	1.5	.0	.3
11	5.1	4.8	.3	.4	3.1	.1	.0	.7
12	3.2	.7	1.1	.7	3.2	.5	.01	.9
13	1.4	5.2	.0	.4	1.9	7.8	.0	.5
14	6.2	1.9	2.9	3.2	1.7	.8	3.7	.6
15	15.0	16.5	.5	4.6	11.5	17.0	.1	5.4
16	2.9	1.8	.2	1.1	3.3	1.0	.0	1.0

trails are also involved in regular commercial use, including Rainbow Falls, the loop to Rich Mountain Tower, and the loop to Cataloochee Divide. Cataloochee Divide is an excellent example of horse impact, since the trail is heavily used by horses in the middle section and almost not at all in the eastern section. The middle section has horse-caused, muddy corduroy and is very difficult walking, running erosion class 4 to 5. The eastern section is flat with almost no mud, despite similar topography, and is largely erosion class 1 to 2.

Some sections, largely open to horses and moderately used by private horse parties, are not developing severe problems. This includes Abrams Creek (2), Tremont (4), Twenty Mile (9), and Hazel Creek (10). Some of the more heavily used horse trails in these areas are surfaced jeep roads. On many of the others, horse use is low to moderate and, although there may be some tendency towards small ruts, the trails are still in good condition. In the case of a few trails in these areas, horse use may be compounding severe water erosion problems (the trail from Welsh Ridge into Hazel Creek, for instance), but horse use is not the primary problem.

Vehicle rut is not as common as horse plowing and is usually a minor factor in trail erosion. A few individual trails, such as the lower end of Hyatt Ridge and the lower end of Balsam Mountain, have had problems with this in the past, but the closure of these to jeeps should eventually relieve this. In a few places, like Hyatt Ridge, the vehicle tracks were creating small mudholes, and heavier use by vehicles would have significantly deteriorated the trail. Most unsurfaced trails hold vehicle tracks for long periods of time (several months or more if they are deep ruts). Vehicle use on any unsurfaced trail should certainly be considered "emergency only."

Table 15. Width and Erosion Measurements for Individual Trails - Horse Impacted Trails

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail o	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
Section 1														
3	10	159	143	90	6	6	1	4	1	7	23	2.5	2.6	3.0
4	12	86	61	71	8	4	7	2	4	6	8	2.3	2.7	2.2
5	12	138	106	77	4	4	11	8	8	11	10	2.6	2.9	2.8
6	16	98	86	88	10	4	6	8	5	14	2	2.8	2.9	2.9
10 **	11	112	102	91	16	6	106	36	82	20	0	3.5	3.5	3.6
12	7	159	159	100	11	3	16	44	1	11	1	5.0	5.0	4.4
Section 2														
1	9	329	189	57	2	2	4	10	5	0	2	2.8	2.6	2.6
3	12	91	32	35	0	2	3	0	3	0	0	1.8	1.8	2.0
Section 3														
2	11	187	182	97	12	3	0	70	2	3	43	4.0	3.9	4.7
3 *	10	182	127	70	6	3	174	22	26	6	35	3.2	3.5	4.0
4 *	6	198	158	80	7	1	0	39	35	5	27	4.0	4.0	3.8

Table 15. Width and Erosion Measurements for Individual Trails - Horse Impacted Trails - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail o	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
Section 3 - Cont.														
11	5	366	360	98	6	4	0	1	3	0	2	1.8	2.4	2.8
12	6	405	405	100	3	4	0	1	17	0	9	3.7	3.7	3.7
14	5	278	252	91	16	2	2	40	10	0	7	1.8	2.4	3.8
15	6	382	327	86	12	5	1	0	12	1	3	3.5	3.5	3.2
16	9	199	193	97	15	5	0	2	18	7	4	3.7	3.7	3.9
21	12	174	122	70	1	3	12	0	8	5	14	2.9	3.1	2.8
29 *	10	253	253	100	1	3	1	0	47	1	1	2.4	2.4	4.4
Section 6														
4 *	4	200	160	80	6	3	34	13	28	0	14	2.0	2.8	3.5
5	10	165	94	57	4	6	12	8	11	3	1	2.0	2.4	2.7
6 *	5	308	250	81	8	4	47	46	37	0	20	2.6	3.2	4.4
7 **	10	218	199	91	9	5	59	100	100	1	2	2.8	3.2	4.5
8	9	237	156	66	7	5	29	19	17	5	21	2.6	2.8	3.3

Table 15. Width and Erosion Measurements for Individual Trails - Horse Impacted Trails - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
Section 6 - Cont.														
9 *	6	188	123	65	8	5	31	16	28	0	1	2.5	2.8	3.3
10	2	250	235	67	3	3	25	9	18	0	0	2.5	2.5	4.0
16	8	139	93	67	9	6	14	24	9	13	1	2.5	2.5	3.3
17	6	107	80	75	8	7	7	16	3	14	0	2.7	2.5	2.7
18 *	7	164	109	66	7	4	53	8	18	2	1	2.7	2.9	4.4
19 *	5	115	124	108	11	7	21	36	14	33	0	3.2	3.0	3.8
22	4	265	218	82	4	5	25	14	18	0	23	2.5	2.8	3.5
24	4	135	115	85	10	10	2	44	2	6	0	3.0	3.0	4.0
26	10	229	209	91	4	4	18	9	12	2	3	2.1	3.0	3.2
27	6	263	243	92	4	4	12	11	8	6	11	2.8	3.0	2.8
29 *	4	160	148	93	1	8	16	45	16	24	33	3.0	3.3	4.3
30	7	197	135	69	6	7	14	50	13	25	11	2.9	3.0	4.4
31	13	171	132	77	13	6	1	0	1	6	2	2.8	2.9	2.9

Table 15. Width and Erosion Measurements for Individual Trails - Horse Impacted Trails - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
Section 6 - Cont.														
33	14	141	99	70	15	6	11	16	10	17	4	2.9	3.1	2.9
35 *	23	159	134	84	11	7	22	12	16	19	13	3.2	3.3	3.3
67	10	166	160	96	8	7	17	40	8	31	9	3.3	3.1	4.1
Section 7														
11	21	173	148	86	5	7	3	18	1	20	3	2.7	2.6	3.0
13	8	208	184	88	4	9	3	6	1	16	18	2.4	2.5	2.6
14	2	115	110	96	5	8	5	43	8	30	0	3.0	3.0	4.0
23	5	116	90	78	5	5	3	0	2	6	9	2.4	2.8	2.8
Section 8														
3	9	111	48	43	4	3	0	0	5	1	4	1.4	2.0	1.8
4	5	220	184	84	1	1	0	3	3	0	60	2.8	2.8	3.8
6	16	106	39	37	3	3	0	8	1	0	12	1.9	1.6	2.6

Table 15. Width and Erosion Measurements for Individual Trails - Horse Impacted Trails - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
Section 10														
10	17	114	70	61	4	2	0	5	3	7	12	2.5	2.3	2.4
11	12	225	162	72	12	6	8	34	8	8	13	3.9	3.8	4.3
12	3	213	63	30	1	7	1	0	5	6	1	2.0	2.0	2.0
Section 11														
1	19	310	99	32	3	6	2	7	8	0	24	2.7	2.7	2.7
11	13	92	55	60	5	4	2	0	2	1	8	2.1	2.0	2.0
12 *	18	124	79	64	4	7	3	5	37	2	7	2.4	2.3	2.7
Section 12														
2	12	224	176	79	6	4	4	0	3	4	20	3.5	3.5	3.8
3	12	193	98	51	5	2	11	0	6	4	1	3.8	3.8	3.3
7	20	103	40	39	2	4	0	2	1	1	4	1.7	1.4	1.6
28	12	153	118	77	4	5	0	4	4	0	7	2.4	2.3	2.3
30	4	100	55	55	0	5	3	5	3	1	6	2.0	1.8	2.0

Table 15. Width and Erosion Measurements for Individual Trails - Horse Impacted Trails - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
Section 13														
4	15	129	108	84	6	4	2	6	5	8	5	3.3	3.3	3.3
6	11	325	277	85	5	7	0	5	2	3	5	2.8	2.5	2.8
13 **	7	234	207	88	6	4	15	53	61	0	36	4.3	4.3	5.0
14	5	110	66	60	0	3	2	4	6	7	18	2.8	2.8	2.0
15	13	144	125	87	4	4	0	5	1	9	3	2.3	2.1	2.4
16	19	90	69	77	5	3	0	0	9	7	3	1.7	1.6	2.1
Section 15														
1	10	161	101	63	4	5	18	2	3	6	0	3.7	3.7	3.1
2	5	329	246	75	2	1	100	0	5	0	0	3.0	3.0	3.2
3	7	261	199	76	4	6	2	1	2	2	7	3.6	3.6	2.4
4 *	14	166	95	57	8	5	15	1	20	3	1	2.7	2.4	2.7
5 *	16	294	200	68	5	5	35	9	35	8	1	3.3	3.0	3.3
6 *	13	126	84	67	6	3	15	6	23	5	8	3.2	3.3	3.0

Table 15 Width and Erosion Measurements for Individual Trails - Horse Impacted Trails - Cont.

Trail No.	N	Width cm	Width cm	Tread %	Depth cm	Slope Trail o	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
Section 15 - Cont.														
7	24	153	123	80	10	4	5	32	4	17	1	3.8	3.9	3.8
8	9	257	122	56	4	3	1	0	5	3	5	3.2	3.2	2.3
9	9	261	146	56	1	4	6	0	22	0	6	3.4	3.4	3.3
10 *	19	158	78	49	10	3	15	19	29	4	6	3.0	2.5	2.7
11 **	6	217	122	56	7	5	63	68	90	3	0	4.3	4.5	4.8
12	14	105	42	40	2	3	0	3	4	0	2	1.6	1.3	1.5
13 *	4	168	100	60	6	3	16	1	36	7	0	4.0	4.0	3.5
14	5	244	154	63	3	1	5	2	8	1	0	2.8	2.8	3.0
15	8	244	116	48	2	1	37	11	20	6	0	4.1	4.1	3.8
16 **	8	175	164	94	6	4	27	6	65	0	1	3.9	3.9	4.5
17	8	198	114	58	4	8	3	17	4	0	0	3.0	3.0	3.0
19	10	206	113	55	61	3	11	0	15	0	9	3.4	3.4	3.2

Table 15. Width and Erosion Measurements for Individual Trails - Horse Impacted Trails - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
Section 16														
3	12	156	136	87	9	5	0	0	2	11	11	3.2	2.9	3.3
4	18	413	284	69	0	1	0	0	4	1	2	2.1	2.1	2.5
5	11	236	124	53	3	5	4	6	2	4	19	3.1	3.1	3.4
6	11	211	95	45	3	3	16	11	5	2	6	2.8	2.9	3.7
7	5	208	158	76	5	4	4	0	1	12	1	4.4	4.4	4.6
Section 14														
1	12	92	77	84	2	4	2	2	2	6	3	1.9	1.8	2.1
2	8	184	184	100	1	5	0	0	2	2	25	3.4	3.5	3.1
5	9	90	63	70	0	4	3	1	1	7	2	2.0	2.0	1.5
6 *	16	162	139	86	2	3	31	13	12	23	8	3.4	3.3	3.7

* Horse Plow $\geq$ 10%

** Horse Plow $\geq$ 50%

HOG ROOTING

Hog rooting along trails was found in all sections except 7, 14, 15, and 16 (not occupied, or invasion areas at the time of the survey). Two sections had moderately high amounts of trail-side rooting, the Appalachian Trail (6.5 percent) and Hazel Creek (8.7 percent) (Table 16). In both cases, hog rooting is locally causing erosion on the sides of the trail and, in the case of the Appalachian Trail, hog wallowing may be expanding a number of mudholes.

Table 16. The Average Amount of Hog Rooting by Section.

Trail Section	Hog Rooting at Site	Total % Hog Rooting
1	5.0	6.5
2	.8	.7
3	1.3	1.4
4	1.5	1.5
5	1.2	2.6
6	1.1	.1
7	.0	.0
8	.3	.1
9	.2	.2
10	4.5	8.7
11	1.8	3.1
12	.2	1.2
13	.1	.1
14	.0	.0
15	.0	.0
16	.0	.0

The Relationship of Forest Type to Trail Condition

Forest type is one of the most important ecological variables in the park and is strongly related to trail condition. Of the major forest types in the park, spruce-fir forest is, by far, the most erosion sensitive (Table 17). All types of erosion are more prevalent in spruce-fir than in other closed canopy types. Exposed roots are four times as common and bare rock is seven times as common as in the xeric types (oak and pine forest). Early successional types with an open canopy are also very liable to erosion, particularly rutting.

The effect of changes in forest type on trail conditions under equal visitor load can be seen quite easily on trails like Goshen Prong and Noland Divide. On Noland Divide, as the trail goes from spruce forest to oak, the trail improves from an erosion class 4 to class 2. Goshen Prong has similar changes as the trail grades from spruce (class 4) into fire cherry (class 3), into lower elevation successional hardwoods (class 2). Since these are long-distance trails with no campsites, traffic should be evenly distributed along their lengths or be slightly greater at the lower elevations where the trails are actually in better condition.

Table 17 The Relationship of Forest Type to Soil Erosion, Maintained Trails Only

	N	Width cm	Tread Width cm	%	Depth cm	Water %	Mud %	Rut %	Rock %	Roots %	Side Erosion %	Erosion Rating	Computer Erosion Rating
Spruce Fir Northern	302	125.1	98.1	78	8.2	16.2	10.9	16.7	39.9	17.3	8.1	3.0	3.2
Northern Northern Hardwood	180	129.4	95.0	73	4.8	10.9	5.7	6.5	10.7	12.0	4.2	2.9	2.7
Mesic Types	575	152.1	97.8	64	3.9	6.7	5.0	8.4	13.7	9.7	5.7	2.6	2.9
Xeric Types	731	132.1	73.0	55	3.3	5.1	3.0	5.7	5.9	3.9	6.4	2.0	2.3
Early Successional	47	117.0	73.2	63	7.8	14.6	6.6	22.5	16.1	3.5	1.8	3.0	3.3
TOTAL	1835	136.6	87.4	64	4.6	8.2	8.9	8.9	14.6	8.7	6.1	2.5	2.7

breaking the major canopy types into subgroups. There appear to be some differences in the amount of erosion within the major types. All the subgroups in spruce-fir indicate poor conditions, but stands with mature yellow birch are in slightly better condition and, as one would suspect, are more similar to mixed northern hardwoods (Table 1).

The northern hardwood group is exceedingly variable, with gray beech forest being as poor as the spruce-fir while often surrounds it, and the successional northern hardwoods are in relatively good condition (most of the trails in the latter type are on old railroad grades).

The lower elevation mesic types are more consistent with each other, but the hemlock hardwoods and hemlock types have more poor samples than the others. Coniferous soils and relatively wet conditions may be responsible.

The xeric types are also fairly consistent, the pine types (which are the driest) having slightly fewer poor sections than the oak types. White pine does not fit the pattern of this group and it is possible that the white pine type should, in reality, be placed with the more mesic flats and streamside communities.

Among the open successional types, trails on balds and burn scars are in far worse condition than those in pastures and old fields. Data indicates that rutting is still a problem throughout these open types, however.

Differences can also be seen among the various successional stages. The samples rated as "virgin" had the worst erosion ratings (Table 19). Exposed roots are far more prevalent in "virgin" and "mature" stands than in those considered successional or early successional. This indicates that the erosion on the trails may be damaging the canopy in some of the most distinctive forest stands in the park. Much of the "virgin" forest is at high elevations or on steep slopes, which may account for part of the difference in damage. The "virgin" forest in the park is also largely in intensely used sections such as the Appalachian Trail (1), LeConte (6), Cosby (7), and Cades Cove (3).

When successional stages are broken down by section, some show less difference in damage than others (Table 20). LeConte-Cosby area (6-7), which is largely in fair-to-poor condition, shows less differentiation among successional groups than do a number of others such as Tremont-Elkmont (4-5). This is

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Table 18. The Relationship of Specific Canopy Types to Erosion Ratings.

	Erosion Rating		
	Good 1-2	Fair 3	Poor 4-5
Spruce-fir			
1-1 Spruce-fir	53 26%	99 40%	85 34%
1-2 Spruce-fir-hemlock	11 24%	16 36%	18 40%
1-3 Yellow birch (mature)	32 48%	14 30%	10 22%
1-4 Heath bald	6 40%	6 40%	3 20%
Northern Hardwoods			
2-1 Gray beech	15 28%	17 32%	21 40%
2-2 Mixed northern hardwoods	65 43%	48 32%	38 25%
2-3 Successional northern hardwoods	26 60%	15 35%	2 5%
Mesic Types			
3-1 Mixed cove hardwoods	26 60%	15 35%	2 5%
3-2 Hemlock-hardwood	125 45%	107 39%	46 16%
3-3 Mesic-hardwood flats	47 71%	14 21%	5 8%

Table 18. The Relationship of Specific Canopy Types to Erosion Ratings - Cont.

		Erosion Rating		
		Good 1-2	Fair 3	Poor 4-5
3-4	Successional cove	39 52%	29 39%	7 9%
3-5	Mesic-sub-mesic	87 47%	72 38%	29 15%
3-6	Tulip tree	47 63%	21 28%	7 9%
3-7	Hemlock cove	12 43%	8 29%	8 28%
Xeric Types				
4-1	Mixed sub-xeric	179 69%	57 22%	22 9%
4-2	Mixed oak	296 65%	118 26%	40 9%
4-3	White oak	19 72%	4 16%	2 8%
4-4	Mixed oak-pine	181 69%	68 26%	12 5%
4-5	Mixed pines	96 73%	29 22%	7 5%
4-6	White pine	10 47%	5 24%	6 29%
Successional Types				
5-1-2	Balds, burn scars	4 20%	4 20%	12 60%
5-3	Pastures, old fields	12 60%	6 30%	2 10%
5-4-5	Shrubs	17 52%	9 27%	7 21%

Table 19. The Relationship of Successional Stage to Erosion

Stage	N	Width cm	Tread Width cm	Depth cm	Mud %	Rut %	Rock %	Roots %	Side Erosion %	Erosion Rating	Computer Erosion Rating
Virgin	304	143.3	107.1	6.7	11.8	12.5	21.4	16.1	7.5	3.1	3.2
Mature	485	148.5	101.9	4.2	4.5	9.3	18.4	12.5	5.7	2.6	2.7
Successional	1693	176.0	124.6	3.8	5.4	7.3	10.3	4.1	6.6	2.3	2.6
Early Successional	164	219.4	133.0	5.4	9.3	10.4	13.7	2.5	1.9	2.5	2.8

Table 20. The Relationship Between Successional Stage to Erosion for Selected Sections

Section	Stage	Width cm	Tread Width cm	Depth cm	Elevation ft	Mud %	Rut %	Rock %	Roots %	Side Erosion %	Erosion Rating	Computer Erosion Rating
1 Appalachian Trail	Virgin	119	112	11	5550	33	22	26	19	2	3.4	3.5
	Mature	135	115	5	5020	5	5	32	10	5	3.1	2.7
	Successional	132	87	6	4290	3	5	22	10	8	2.6	2.6
	Early Successional	92	78	13	5500	10	39	23	6	1	3.8	4.1
4-5 Tremont-Elkmont	Virgin	168	131	6	4680	11	17	23	10	22	3.4	3.3
	Mature	161	121	1	3860	1	1	4	5	3	1.8	2.2
	Successional	204	134	3	2850	1	3	4	5	5	2.1	2.5
	Early Successional	137	86	1	3650	2	1	4	3	1	1.7	2.0
6-7 LeConte-Cosby	Virgin	127	102	9	4740	6	10	40	21	12	2.8	3.0
	Mature	140	104	7	3700	4	19	29	25	6	2.7	3.2
	Successional	183	145	6	2750	11	19	23	9	6	2.5	3.1
	Early Successional	216	185	11	2850	6	7	45	7	6	2.4	3.3

Table 20. The Relationship Between Successional Stage to Erosion for Selected Sections - Cont.

Section	Stage	Width cm	Tread Width cm	Depth cm	Elevation ft	Mud %	Rut %	Rock %	Roots %	Side Erosion %	Erosion Rating	Computer Erosion Rating
11-12 Forney-Deep Creek	Virgin	178	107	5	4490	10	19	16	17	4	3.3	3.3
	Mature	113	47	1	4180	2	1	4	6	4	1.8	1.9
	Successional	192	103	2	3030	4	5	7	2	7	2.3	2.3
	Early Successional	262	139	3	2950	3	5	11	1	2	2.5	2.6
15-16 Big Creek-Cataloochee	Virgin	156	101	3	4390	3	11	3	14	5	3.3	3.3
	Mature	165	101	6	4500	6	8	15	16	4	3.3	3.1
	Successional	195	118	7	3670	7	9	7	11	4	2.6	2.8
	Early Successional	278	143	4	3660	4	24	3	5	1	2.8	2.8

probably due both to the generally high use in the LeConte area and the fact that many of the trails in successional forest around LeConte are horse trails. The pattern of greater damage in old growth stands does hold for the remainder of the park. The forested successional samples from the Appalachian Trail (1), for instance, are in better condition than the virgin samples. The open grass balds and burn scars, however, are badly rutted and have poor erosion ratings.

The amount of erosion is also related to the type of understory. Herbaceous communities seem to have slightly more damage than shrub-sapling and ericaceous types (Table 21). Since most of the better wild flower areas in the park would fall in the "herbaceous" category, it is important to note that more of these samples received poor erosion ratings. The somewhat poorer conditions of samples from herbaceous understory is also noticeable in the individual types shown in Table 22.

Table 21. The Relationship of Major Understory Types to Erosion Rating.

	Erosion Rating				
	1	2	3	4	5
Shrub-sapling seedling	199 25%	269 33%	239 30%	72 9%	24 3%
Ericaceous	274 24%	414 35%	370 31%	127 11%	10 1%
Herbaceous	101 14%	269 36%	223 30%	113 15%	35 5%

Chi-square = 70.8 with 8 d. f. $p > .0001$

Table 22. The Relationship of Specific Understory Types to Erosion Rating

	Erosion Rating		
	Good 1-2	Fair 3	Poor 4-5
Herb Understory			
Spruce-fir and heath balds	32 39%	36 44%	14 17%
Bramble-sedge-herb	11 34%	12 38%	9 28%
Vacciniun	2 10%	7 33%	12 57%
Spruce-fir seedling	41 38%	39 36%	27 25%
Rhododendron	30 29%	34 34%	39 37%
Herb	2 7%	13 43%	15 50%
Mesic-submesic			
Mesic herbs	177 48%	121 33%	67 18%
Submesic	67 57%	29 25%	23 18%
Rhododendron	219 47%	165 36%	80 17%
Dog hobble	14 48%	12 41%	3 10%
Hemlock shrub	60 50%	54 45%	7 6%

Table 22. The Relationship of Specific Understory Types to Erosion Rating - Cont.

	Erosion Rating		
	Good 1-2	Fair 3	Poor 4-5
Sapling	131 56%	74 32%	29 11%
Xeric			
Vaccinium	112 75%	27 18%	10 6%
Sapling	234 74%	59 19%	25 8%
Laurel	126 74%	40 19%	14 7%
Rhododendron-Laurel	113 56%	80 39%	10 5%
Rhododendron	62 57%	34 32%	10 9%
Xeric herbs	73 61%	34 27%	15 12%
Open			
Grass sedge	21 63%	5 15%	7 21%
Bramble-shrub	13 36%	12 33%	11 31%

The Relationship of Physical Environment and Trail Construction to Trail Condition

As one would suspect, several environmental factors are related to trail condition. Probably the most important of these is the slope of the trail, which has a correlation of .209 to erosion rating and high correlations to rut (.181), rock (.183), and exposed roots (.292) (Tables 23 and 24). Slope of the environment has somewhat lower correlations than slope of the trail, with the exception of bank erosion (.195). Slope of the environment has significant negative correlation to rut (-.049) and water erosion (-.066). Trail angle with the slope (the difference between the trail aspect and the slope aspect (0^{o} - 90^{o}) has a significant correlation to all types of erosion except bare rock. These correlations are all negative (like exposed roots, -.116) except for bank erosion (.092). In general, low trail angles (0^{o} - 10^{o}) have the worst erosion ratings. Elevation has strong positive correlations with several types of erosion, particularly rock (.294), roots (.300), and water (.190). This is partially a function of forest type, but may also be related to higher rainfall and shallower soils on high ridges. These relationships also provide

significant Chi-square tests when the information is blocked into groups. Tables 25 through 29 show a few examples and also show the percentages.

Some of these environmental factors are correlated to each other (Table 30). Slope of the trail and slope of the environment and trail angle are all related to each other. Elevation, ironically, is only mildly related to the slope of the trail, and showed no significant correlation to the slope of the environment. This implies that the greater erosion at higher elevations has little relationship to steeper slopes and is probably not due to steeper trails. Different types of erosion are also related to each other and tend to co-occur (Table 31). Rock, roots, water, and rut are all closely related, rock and rut having the strongest correlation (.340). Bank erosion and mud have weaker correlations to the other types.

Erosion measurements are not all equally correlated to erosion ratings. The ratings done in the field (erosion and overall) emphasized water erosion, with roots, rut, and rocks next in importance. The computer erosion rating is somewhat more closely correlated to mud and bank erosion (Table 32). Erosion

Table 23. Correlations Between Environmental Factors and Trail Condition

	Mud	Rut	Rock	Roots	Water	Bank	Horse Plow	Foot Plow
Slope of the trail	.016	.181*	.183*	.292*	.160*	.036*	.022	.049*
Slope of the environment	-.024	-.049*	.091*	-.001	-.066*	.195*	-.025	-.001
Trail angle with slope	-.052*	-.082*	-.027	-.116*	-.056*	.092*	-.040*	-.040*
Elevation	.026	.082*	.294*	.300*	.190*	.013	.003	.063*

* $p > .05$

(Water excludes Sections 6, 7, and the eastern half of Section 1, where presence/absence data were used.)

Table 24. Correlations of Environmental Factors with Erosion Ratings

	Erosion	Overall	Computer Erosion
Slope of the trail	.209*	.208*	.213*
Slope of the environment	-.061*	-.067*	.019
Angle of the trail with the environment	-.105*	-.117*	-.125*
Elevation	.278*	.274*	.110*

* $p > .05$

Table 25. The Relationship of Erosion Rating to Trail Angle with the Slope

Trail Angle	Erosion Rating				
	1	2	3	4	5
$\leq 10^0$	127 22%	187 19%	212 24%	113 32%	36 44%
$>10^0 \leq 80^0$	184 32%	358 36%	349 39%	127 37%	20 25%
$>80^0$	271 47%	446 45%	327 36%	104 30%	25 31%

(Column percentages)

Chi-square = 70.56 with 8 d.f. $p > .0001$

Table 26. Relationship of Trail Angle to Exposed Roots

Trail Angle	Exposed Roots					
	0	≤5%	≤15%	≤30%	≤50%	>50%
≤10°	310 22%	150 23%	103 24%	56 25%	27 30%	29 45%
>10° ≤ 80°	486 34%	234 36%	159 37%	97 42%	40 44%	22 34%
>80°	634 44%	267 41%	160 37%	75 32%	24 26%	13 20%

(Column percentages)

Chi-square = 43.2 with 10 d. f. p = .0001

Table 27. The Relationship of Mud to Trail Angle

Trail Angle	Percentage of Mud					
	0	≤5%	≤15%	≤30%	≤50%	>50%
≤10°	432	116	63	18	22	24
	22%	21%	31%	19%	33%	45%
>10° ≥80°	677	203	77	40	23	18
	35%	37%	38%	43%	34%	34%
>80°	812	231	62	35	22	11
	42%	42%	31%	38%	33%	21%

(Column percentages)

Chi-square = 36.1 with 10 d. f. p .0001

Table 28. The Relationahip of Trail Slope to Rut

Slope		Percentage of Rut				
		0	≤5	≤15	≤30	≤30
0^0		179 66%	32 12%	23 9%	18 7%	18 6%
$>0^0$	3^0	801 71%	147 13%	84 7%	59 5%	41 4%
$>3^0$	6^0	524 60%	131 15%	93 11%	64 7%	69 8%
$>6^0$	10^0	180 39%	72 16%	74 16%	62 13%	74 16%
$>10^0$		62 44%	15 11%	16 11%	16 11%	32 23%

(Row percentages)

Chi-square = 232.9 with 20 d. f. $p > .0001$

(5 and 6 Columns summed in above table)

Table 29. The Relationship of Elevation to Erosion Rating

Elevation	Erosion Rating 1-2	3	4-5
<2000´	227 70%	120 25%	18 4%
<3000´	518 59%	263 30%	102 11%
<4000´	443 56%	199 32%	78 12%
<5000´	258 52%	159 32%	82 16%
>5000	126 30%	147 35%	147 35%

(Row percentages)

Table 30. Correlations Among Environmental Factors

	Slope of the trail	Slope of the environment	Trail Angle with Slope	Elevation
Slope of the trail	*	.207*	-.126	.048*
Slope of the environment		*	.433*	.019
Trail angle with slope			*	.022
Elevation				*

* $p > .05$

Table 31. Relationship of Erosion Measurements to Erosion Ratings

	Mud	Rut	Rock	Roots	Water	Bank	Horse Plow	Foot Plow
Erosion	.152	.412	.401	.428	.489	.180	.150	.123
Overall	.170	.397	.432	.422	.454	.170	.169	.115
Computer Erosion	.234	.496	.366	.376	.533	.292	.221	.149

(All correlations significant $p > .05$)

Table 32. Correlations of Erosion Types with Each Other

	Mud	Rut	Rock	Roots	Water	Bank	Horse Plow	Foot Plow
Mud	*	.160*	.044*	.051*	.120*	.074*	.550*	.147*
Rut		*	.340*	.293*	.278*	.090*	.412*	.510*
Rock			*	.275*	.288*	.152*	.052*	.027*
Roots				*	.199*	.034	-.022	.064*
Water					*	.158*	.027	.065*
Bank						*	.031	-.008
Horse Plow							*	.470*
Foot Plow								*

* p > .05

ratings, of course, are all strongly correlated to each other (Table 33).

Looking at two factors at once shows how choices made during trail construction may compound erosion problems. High trail slopes and low trail angles are both associated with erosion problems. Table 34 shows the effects of a steep slope and a low angle together. Forty-five percent of the trail samples with $\leq 10^{o}$ angle and $> 10^{o}$ slope were in the poorest erosion classes. Although steep slopes are also related to an increase in erosion on trails with angles $> 80^{o}$, the effect of steep grades is more marked at lower trail angles.

This sort of relationship also occurs with canopy type. Northern hardwoods and open successional vegetation, for instance, have a large percentage of trails with low angles (Table 35).

In both cases this may be encouraging rutting, a severe problem in open successional areas. On some burn scars and grass balds the trails have been laid straight along the ridge top in the vegetation type most sensitive to the type of damage low trail angle encourages. Trail slope also is

Table 33. Correlations of Environmental Ratings

	Erosion	Overall	Computer Erosion
Erosion	*	.897	.693
Overall		*	.672
Computer Erosion			*

*All p > .05

Table 34 . The Relationship of Erosion Class to Trail Slope and Trail Angle

	Trail Slope	Erosion Class 1-2	3	4-5
Trail Angle $\leq 10^0$	0^0	50 13%	20 25%	10 13%
	$\leq 3^0$	138 56%	70 28%	89 16%
	$\leq 6^0$	68 39%	59 34%	47 26%
	$\leq 10^0$	40 26%	49 42%	27 24%
	$\leq 10^0$	18 31%	14 24%	26 45%
Trail Angle $> 80^0$	0^0	91 62%	27 21%	9 7%
	$\leq 3^0$	363 69%	120 23%	44 8%
	$\leq 6^0$	179 53%	117 34%	44 13%
	$\leq 10^0$	73 50%	50 34%	24 16%
	$\leq 10^0$	10 34%	13 45%	6 4%

Table 35. The Relationship of Canopy Type to Trail Angle

Canopy Type	Trail Angle		
	$<10^0$	$>10 \geq 80^0$	$>80^0$
Spruce-fir	82 23%	128 36%	145 40%
Northern Hardwood	82 33%	91 37%	75 30%
Mesic Hardwood	243 23%	406 38%	408 39%
Xeric	232 20%	397 34%	524 46%
Open Successional	36 49%	16 22%	21 29%

Chi-square = 59.58 with 8 d. f. $p > .0001$

not the same in all canopy types. Spruce-fir forest has more 0^{o} trail slopes and more $> 6^{o}$ than other vegetation types. Again, this type of trail placement may be encouraging problems, particularly mud on the flats (Table 36).

A final maintenance factor to look at is the type of trail - foot and horse trails versus former jeep roads. Table 37 shows the relationship of the type of trail and the slope to the erosion class. At 0^{o} slope, former jeep roads are generally in better condition; in the $> 0^{o} \leq 6^{o}$ class a large percentage of foot and horse trails are in the poorest class; but at $> 6^{o}$ slope the poorest class is 24 percent of the trail samples and 22 percent of the former jeep road samples. The same type of pattern may be seen in Table 38 , where elevation and type of trail are related to erosion class. The former jeep roads at the higher elevations fare little better than the foot and horse trails. In most topographic positions, the former jeep trails are having erosion problems equal to those of the foot and horse trails, so it is incorrect to assume that their presence was improving the erosion situation in the backcountry. If access is a critical factor controlling erosion, then jeep roads should be in better condition than the less accessible trails.

Table 36. Relationship of Canopy Type to Trail Slope

Canopy Type	Slope				
	0^0	$\leq 3^0$	$\leq 6^0$	$\leq 10^0$	$>10^0$
Spruce-fir	55	101	109	69	21
	15%	28%	31%	19%	6%
Northern Hardwood	20	86	91	39	12
	8%	35%	37%	16%	5%
Mesic Types	243	406	333	184	61
	9%	41%	29%	16%	5%
Xeric Types	105	470	333	184	61
	9%	41%	29	16%	5%
Open Successional	10	36	20	6	1
	14%	49%	27%	8%	1%

Chi-square = 49.34 with 16 d. f. $p > .0001$

Table 37. The Relationship of Slope and Type of Trail to Erosion Class

Slope of the Trail	Type of Trail	1-2	3	4-5
0^0	Maintained trail	123 66%	42 22%	32 12%
	Jeep road	57 84%	10 15%	1 1%
$>0^0 \leq 3^0$	Maintained trail	446 61%	171 28%	79 11%
	Jeep road	220 60%	101 28%	42 12%
$>3^0 \leq 6^0$	Maintained trail	278 46%	200 34%	117 20%
	Jeep road	112 46%	108 44%	25 10%
$>6^0$	Maintained trail	134 36%	153 40%	92 24%
	Jeep road	53 46%	38 33%	25 22%

Table 38 . The Relationship of Elevation and Type of Trail to Erosion Class

Elevation in Feet	Type of Trail	Erosion Rating 1-2	3	4-5
≤ 2000	Maintained trail	147 72%	48 24%	8 4%
	Jeep road	105 64%	50 31%	8 5%
≤ 3000	Maintained trail	276 57%	147 31%	57 12%
	Jeep road	199 59%	94 28%	40 12%
≤ 4000	Maintained trail	237 56%	130 31%	56 13%
	Jeep road	73 50%	56 37%	20 13%
≤ 5000	Maintained trail	210 54%	115 29%	64 17%
	Jeep road	44 47%	40 43%	9 10%
> 5000	Maintained trail	109 30%	126 35%	123 34%
	Jeep road	17 34%	17 34%	16 32%

Table 39. Average Measurements Environment of Trails by Section.

Trail Section	All trails and roads			Maintained trails		
	Elevation	Slope Trail	Slope Environ.	Elevation	Slope Trail	Slope Environ.
1	4930	4.6	15.4	5140	4.5	14.5
2	1760	3.7	17.7	1830	3.8	24.4
3	2680	4.1	13.4	2700	4.0	14.8
4	3050	4.2	20.1	2980	4.3	20.0
5	3280	5.0	16.7	3400	4.6	18.7
6	3280	6.2	18.9	3810	5.6	20.2
7	3050	5.8	18.2	3110	5.2	19.6
8	2410	3.7	22.8	2300	3.4	23.5
9	2780	3.2	13.4	3060	3.4	15.6
10	2870	4.0	19.0	3520	3.8	17.9
11	3250	3.9	18.3	3660	4.3	19.3
12	3380	3.6	18.1	3780	3.3	18.1
13	3700	3.6	17.8	3930	3.6	19.6
14	4770	4.3	13.5	4580	3.7	15.5
15	4040	4.0	15.7	4200	4.2	15.9
16	3750	3.6	21.2	4050	3.8	20.6

The Relationship between Campsite Damage and Trail Erosion.

One might assume that poor sections in terms of trail erosion would also be poor sections in terms of campsite damage. This is generally true, but there are a few exceptions. Table 40 shows a series of the more important damage values for campsites and trails by section. Two areas, the Appalachian Trail (1) and Cades Cove (3), rate consistently in the worst classes for damage; and four sections - Abrams Creek (2), Tremont (4), Boundary Trail (8), and Deep Creek (12) - were always ranked 10 or below, indicating consistently good conditions. Twenty Mile (9) is also generally low ranked for damage, except bare soil, where it falls in the middle. Heintooga (14) and Elkmont (5) have fair trails and fair campsites. The trails in LeConte area (6) and Cosby area (7) are poor, but the total amount of campsite damage is not relatively as great. Heavy day-hiker use in these areas has discouraged the park from adding campsites. Because of trail conditions, it might be best to continue to limit camping in these sections to a bare minimum. (Note that most of the sites in Cosby section were new at the time of the survey.) Smokemont (13), on the other hand, has trails in fair-to-good condition, but large campsites with bear problems. A park manager has several alternatives in this case. One is to encourage day hiking; another is to disperse camping farther.

Table 40 . Campsite Damage Compared to Trail Damage on a Sectional Basis.

	TRAILS						CAMPSITES					
Section	Computer Erosion	Rank	Water Erosion	%	Depth cm	Rank	Total Damage m^2/mile	Rank	Total Bare Soil m^2/mile	Rank	Average Size of Legal Sites m^2	Rank
1	2.95	(3)	20	(2)	7.4	(3)	5,559	(1)	71	(5)	25,443	(1)
2	2.24	(13)	8	(11)	2.4	(10)	835	(11)	27	(12)	4,220	(10)
3	3.01	(2)	13	(7)	5.0	(4)	2,295	(5)	87	(4)	15,339	(5)
4	2.18	(15)	2	(16)	2.3	(11*)	115	(16)	27	(11)	1,210	(15)
5	2.73	(8)	8	(11)	2.9	(8)	1,111	(6)	54	(6)	8,163	(8)
6	3.15	(1)	34	(1)	7.7	(1*)	1,064	(8)	34	(10)	20,067	(4)
7	2.83	(5)	18	(4)	4.9	(5)	149	(15)	4	(16)	341	(16)
8	2.20	(14)	3	(15)	2.3	(11*)	150	(14)	5	(15)	1,400	(14)
9	2.27	(12)	9	(10)	1.5	(14)	485	(12)	54	(7)	2,155	(13)
10	2.31	(11)	7	(13)	2.1	(13)	981	(9)	121	(3)	2,421	(11)
11	2.61	(9)	16	(5)	4.2	(6)	2,644	(3)	145	(2)	8,246	(7)
12	2.12	(16)	7	(13)	1.2	(15)	329	(13)	24	(14)	2,375	(12)
13	2.48	(10)	11	(8)	3.3	(7)	2,695	(2)	35	(9)	21,260	(3)
14	2.73	(7)	14	(6)	1.0[s]	(16)	1,099	(7)	25	(13)	26,880	(9)
15	2.95	(4)	11	(8)	7.7	(1*)	875	(10)	37	(8)	10,325	(6)
16	2.82	(6)	20	(2)	2.5	(9)	2,477	(4)	267	(1)	22,776	(2)

* = Ties

s = Some trails, depth measurements too low

Hazel Creek (10) trails are in good condition but the campsites have bare soil problems. Adding day hikers is not an alternative, but adding and/or moving campsites is a good possibility. In Forney Creek area the trails are fair and there is a high density of campsite damage. Redistributing backpackers from this area to others such as Deep Creek is a management alternative which would provide relief for both trails and campsites. Cataloochee has poor trails and fair-to-good campsites. As long as the horse use in this area is high, this will probably continue to be the case. Here the manager has to balance horse use against the other types. Addition of backpackers and campsites is presently limited by trail rather than by campsite conditions. Big Creek (16) has trails in fair condition, but the campsites are very large. Again, day use could be further encouraged or camping could be dispersed or relocated.

When making management decisions concerning campsite location and visitor density, it is important to consider both trail and campsite conditions. Variations in the type of visitation (horse versus foot or overnight versus day) and in maintenance and physical environmental factors may mean the trails are in good condition and the campsites in poor condition, or vice versa. Because of high visitation, it is becoming increasingly important

to discriminate usage groups and to try to control the patterns of use. This can be done by campsite placement, limiting access, encouraging day hiking, etc. The state of a whole section, including trails adjoining an area, should be considered before any changes are made.

Conclusion.

Differences in visitation and physical factors have resulted in strong differences in trail condition from one section of the park to another. Although high visitation may be the cause of many erosion problems, trail slope, angle, elevation, and forest type also play an important role. The position of the trail on the slope and the type of maintenance appears to be more important than visitation in many situations. Trails in spruce-fir forest may be difficult to maintain, even if the visitor load is light and the trail is well constructed.

From the data available on backcountry campsite use, it is possible to infer something about visitation patterns. First, backpacking is positively correlated to elevation, so one can assume that longer day hikes might also be. This pattern is probably concentrating use in the most erosion-sensitive ecosystems in the park. In the future, park planning could emphasize more low elevation campsites and trails since, if properly constructed, they should have higher carrying capacities and should be easier to maintain. (The proposed extension of the Boundary Trail from Sugarlands to Cosby is an example of this type of trail). Another possibility is to encourage use in drier and lower elevation areas by increasing access (adding parking areas, etc.) and

decreasing access to higher elevation areas (decreasing campsite numbers or sizes, increasing walking distance by closing gravel access roads, etc.).

A second pattern of backpacking use and, certainly one of day hiker use, is the strong concentration of visitation in certain sections like the Appalachian Trail and LeConte. Although a completely even dispersal of use on the trails throughout the park is neither possible nor desirable, increases in some little-used sections would be a substantial help in keeping the trail free of brush (the Boundary Trail for instance). A small reduction in traffic might not greatly help the poorest trails but, in the case of trails that are in fair condition and still deteriorating, a reduction might help prevent expensive maintenance. Backpackers can be more easily directed than day hikers, and if a small increase in use is desired, they are the group most easily rerouted into the section.

The data presented here indicates that between 15 percent and 20 percent of the trail mileage in the park is in poor condition (110 to 150 miles of trail) and that only 15 percent to 20 percent is in excellent condition. About half the trails investigated have some sort of moderate-to-severe erosion problem. Probably very little can be done to improve this

situation without upgrading backcountry maintenance. Water erosion alone (an estimated 15 percent of the trail surface in the park affected) requires the addition of numerous water bars, a time consuming and costly type of maintenance. Some redistribution of visitation may help, but the severely damaged areas like LeConte and the Appalachian Trail need special attention just to bring chronic problems under control.

A mixed strategy aimed both at controlling visitation and increasing maintenance should be pursued. Doing one without the other will just waste time and money. Rerouting trail sections may help in some severe cases, but again, visitation must be balanced and maintenance be adequate or the new section will end up in poor condition also. There are a number of places in the park where a shift in numbers or types of visitors or an appropriate change in maintenance would control the present problems without major rerouting.

On a sectional basis, steep slopes could be blamed for some erosion problems. LeConte (6) and Cosby (7) both have steeper trails on the average than the rest of the park. This is probably compounding problems with forest type and visitation (Table 39). It is notable, however, that the section with the steepest reported average slope of the environment is the

Boundary Trail (8), which is in good condition but does have bank erosion problems.

The worst sections in the park have a variety of average elevations from 4930 feet (1) to 3280 feet (6) to 2680 feet (3). Although the better sections like 2, 8, and 9 tend to be low, elevation should again be considered a compounding factor rather than one of primary importance in the conditions of the section.

APPENDIX

Individual problem areas and the average widths, depths, percentage erosion, and erosion ratings by trail.

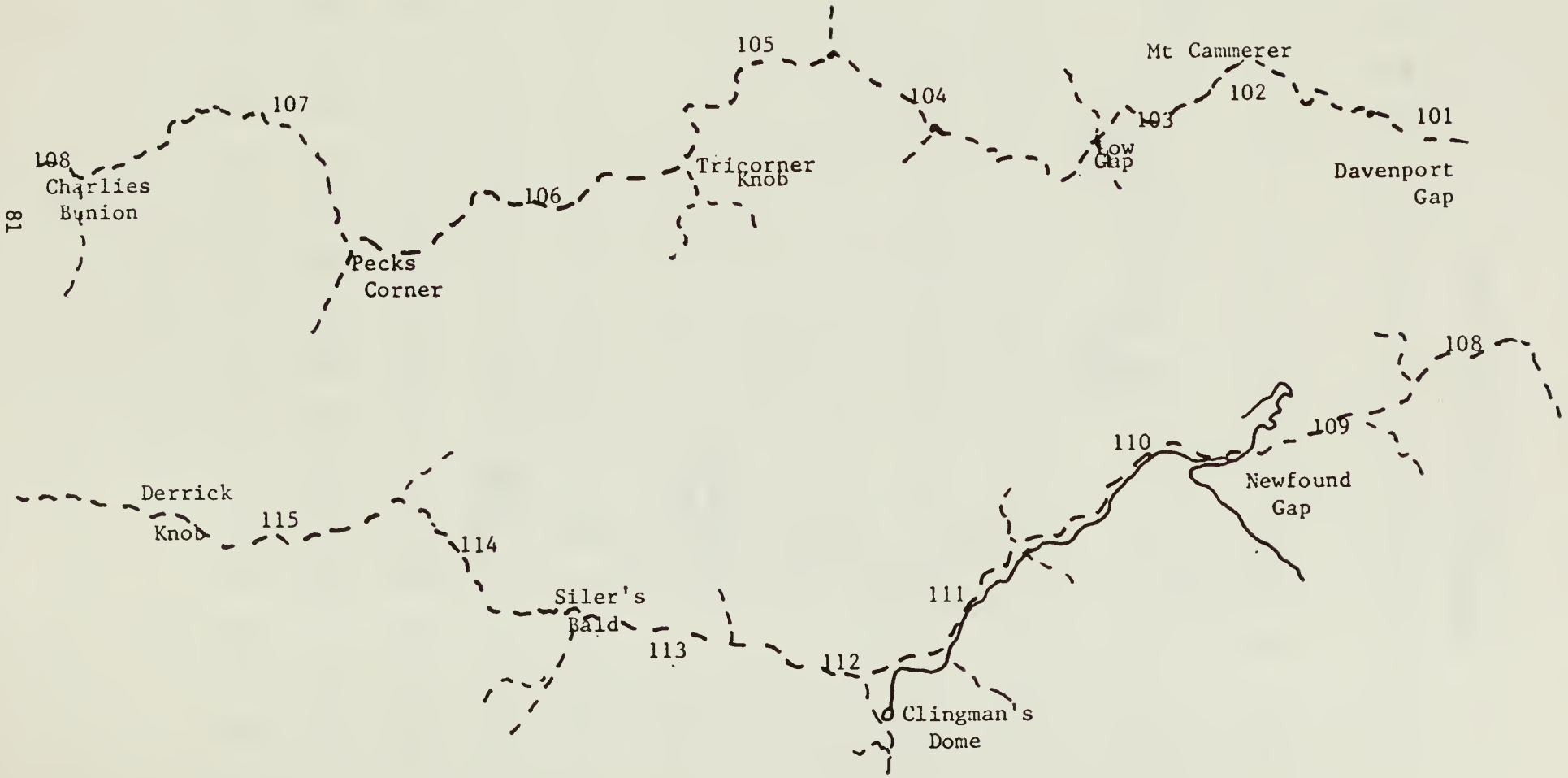
The following appendix includes maps of the sections and tables of average values for trails in a section. There is also a short written description of the areas having the most problems.

Section 1 - The Appalachian Trail.

The worst sections of this long-distance trail are those in the middle, particularly around Clingman's Dome and Thunderhead. The trail improves at either end but is nowhere in better than fair condition. Rut and mud damage is very high around the Dome, and rut is important on the stretch between Derick and Silers. Exposed roots are a severe problem throughout.

This whole trail is in such poor condition that a look at the individual sections on the table following is necessary to distinguish the most severe problem areas.

SECTION 1 - APPALACHIAN TRAIL




116
Derrick
Knob
117
Spence
Field
Russell
Field
118
119
Sassafras
Gap
120
Fontana Dam

Table Section 1 - Width and Erosion Measurements for Individual Trails - Appalachian Trail

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	5	196	160	82	5	6	0	0	0	4	11	1.8	2.0	2.6
2	13	142	93	65	3	5	0	0	0	14	16	1.9	2.3	2.4
3	10	159	143	90	6	6	1	4	1	7	23	2.5	2.6	3.0
4	12	86	61	71	8	4	7	2	4	6	8	2.3	2.7	2.2
5	12	138	106	77	4	4	11	8	8	11	10	2.6	2.9	2.8
6	16	98	86	88	10	4	6	8	5	14	2	2.8	2.9	2.9
7	11	89	60	67	5	5	2	3	0	15	1	2.2	2.5	2.2
8	7	91	86	95	16	3	3	33	0	11	6	2.6	3.0	3.3
9	8	164	133	81	9	2	8	8	0	10	8	2.9	2.9	3.1
10	11	112	102	91	16	6	100	36	82	20	0	3.5	3.5	3.6
11	9	124	124	100	24	6	14	48	0	6	2	4.0	4.0	4.1
12	7	159	159	100	11	3	16	44	1	11	1	5.0	5.0	4.4
13	6	115	115	100	12	5	21	28	0	11	0	4.0	4.0	3.2
14	7	110	110	100	2	3	13	3	0	34	0	3.9	3.9	3.0
15	7	121	126	104	1	4	13	0	0	27	0	3.3	3.3	3.1

Table Section 1 - Width and Erosion Measurements for Individual Trails - Appalachian Trail - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail o	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
16	16	118	125	106	4	7	7	19	0	10	0	3.9	3.9	3.3
17	6	107	90	87	2	4	1	0	0	14	0	3.3	3.3	2.5
18	13	138	73	53	5	6	0	3	0	7	0	3.8	3.8	3.0
19	9	189	79	42	1	4	0	2	0	6	5	2.4	2.4	2.3
20	13	125	79	63	6	5	0	4	0	6	8	2.9	2.6	2.6

SECTION 2 - ABRAMS CREEK

Section 2 - Abrams Creek.

The poorest trail in the Abrams Creek area is the one from Cades Cove to Abrams Fall and Hannah Mountain. The trail is very worn and has a high percentage of exposed rock. Beard Cane (201) has some problems with rut and mud, and the lower end of Rabbit Creek Road (213) has severe water erosion problems and a large eroded area. The remainder of this section is in good to fair condition, and moderate maintenance to control water and bank erosion should suffice.

NOTE: The ford on Abrams Creek is impossible at high water and should be bridged if possible. Connecting the Boundary Trail (801) to 201 would improve traffic flow through trails which can sustain increased use.

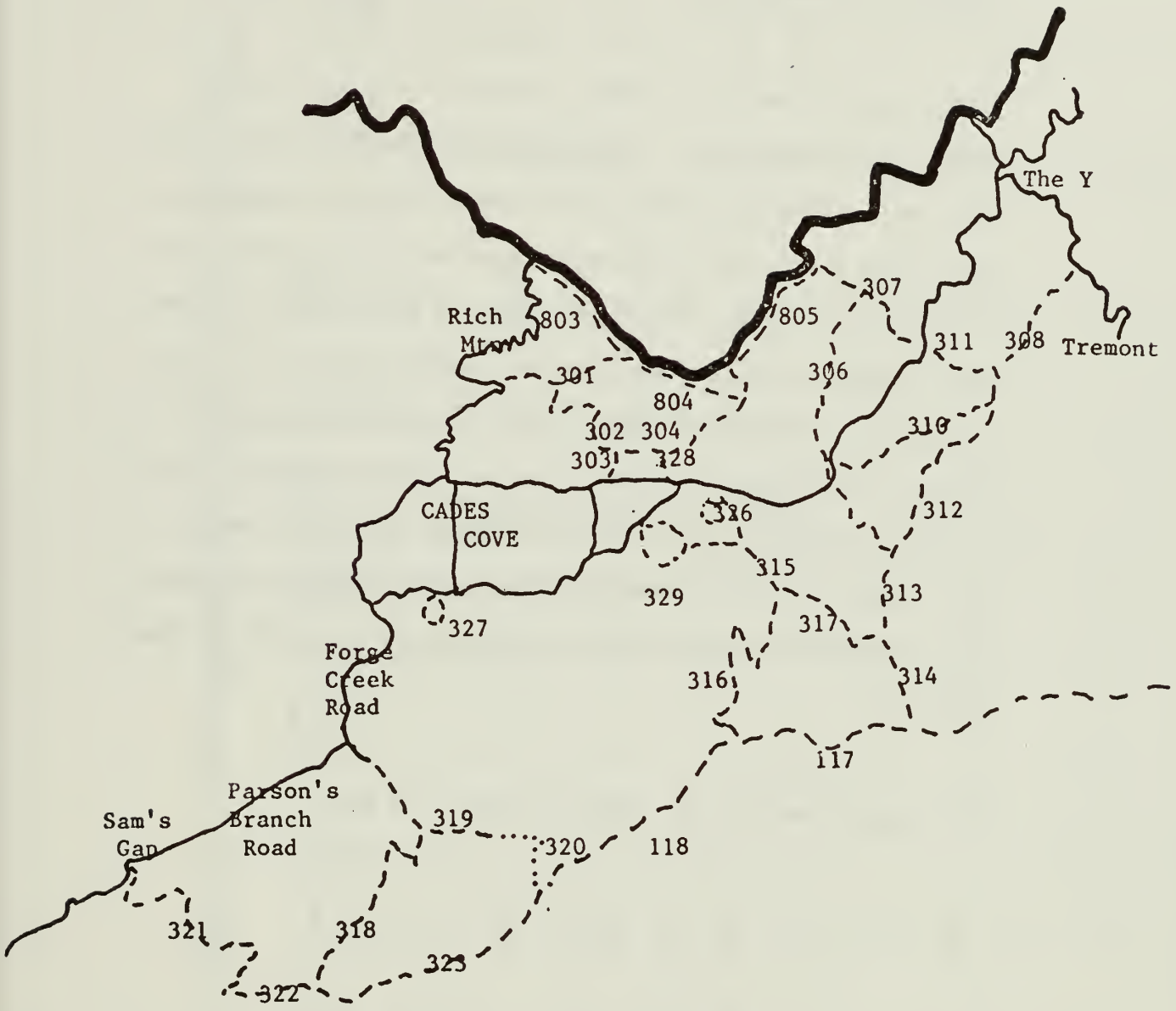
Table Section 2 - Width and Erosion Measurements for Individual Trails - Abrams Creek West of Cade's Cove

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	9	329	189	57	2	2	4	10	5	0	2	2.8	2.6	2.6
2	9	392	234	60	1	3	1	0	0	0	8	2.2	2.0	2.3
3	12	91	32	35	0	2	3	0	3	0	0	1.8	1.8	2.0
4	7	117	54	46	0	4	0	0	0	0	0	1.0	1.0	1.4
5	5	108	38	35	0	2	0	0	0	0	0	1.0	1.0	1.2
6	20	113	49	43	2	2	0	0	0	1	5	1.3	1.1	1.4
7	6	382	207	54	2	3	0	13	0	0	5	2.5	2.0	3.2
8	7	101	74	73	0	7	0	0	0	4	1	2.0	2.0	1.9
9	8	279	165	59	1	4	0	0	0	0	1	1.9	1.9	2.6
10	6	407	333	82	7	4	0	1	0	0	0	2.5	2.0	2.3
11	7	137	96	70	4	7	0	0	0	1	0	2.6	2.7	1.9
12	6	188	183	97	12	7	0	0	0	5	2	3.2	3.2	3.5
13	15	297	167	56	4	5	0	10	0	0	7	2.5	2.3	2.9

Table Section 2 - Width and Erosion Measurements for Individual Trails - Abrams Creek West of Cade's Cove - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Erosion Rating
15	4	335	145	43	2	4	0	2	0	0	0	2.5	2.0	2.5
16	2	185	70	38	3	3	0	0	0	0	0	3.0	2.0	5.0

SECTION 3 - CADES COVE



Section 3 - Cades Cove

Cades Cove section has a number of poor trails and has very heavy use in some areas. The loop to Rich Mountain Tower has mud, rut, and water erosion on the lower sections (Crooked Arm (304), the trail (302) from Indian Gap Road to the John Oliver cabin, and the lower connecting trails to the stables). Upper Bote Mountain (314) has problems with water erosion, mud, and horse plow. Anthony Creek Road (315) has some problems with horse plow and water erosion. The trail (316) to Russell Field (Ledbetter Ridge) has mud, water erosion, and horse plowing. The trail (322) across Gregory Bald is badly rutted, and there are severe problems with water erosion in the vicinity of Sheep Pen Gap.

Good trails include 301, 306, 307, 308, and 310.

Table Section 3 - Width and Erosion Measurements for Individual Trails - Cades Cove Area

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail o	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	6	305	169	55	2	2	0	6	0	1	31	2.0	1.8	2.7
2	11	187	182	97	12	3	0	70	2	3	43	4.0	3.9	4.7
3	10	182	127	70	6	3	74	22	26	6	35	3.2	3.5	4.0
4	6	198	158	80	7	1	0	39	35	5	27	4.0	4.0	3.8
5	2	425	350	82	7	2	0	20	0	20	3	3.0	4.0	4.0
6	12	133	69	52	4	2	0	1	0	3	11	2.4	2.0	2.9
7	6	473	301	64	2	4	0	0	0	0	6	1.0	1.0	2.0
8	7	108	62	57	6	6	0	5	0	12	2	2.3	2.0	1.9
9	8	108	44	41	4	2	0	9	0	8	3	1.9	2.1	2.0
10	7	91	41	45	6	8	0	17	0	13	1	2.6	2.6	2.3
11	5	366	360	98	6	4	0	1	3	0	2	1.8	2.4	2.8
12	6	405	405	100	3	4	0	1	17	0	9	3.7	3.7	3.7
13	4	350	97	5	7	0	2	0	0	0	4	2.0	2.3	3.0
14	5	278	252	91	16	2	2	40	10	0	7	1.8	2.4	3.8

Table Section 3 - Width and Erosion Measurements for Individual Trails - Cades Cove Area - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
15	6	382	327	86	12	5	1	0	12	1	3	3.5	3.5	3.2
16	9	199	193	97	15	5	0	2	18	7	4	3.7	3.7	3.9
17	8	206	132	64	4	5	4	0	0	9	2	2.9	3.1	3.0
18	18	144	123	85	3	5	3	1	0	6	1	2.5	2.5	2.3
19 U	3	113	103	91	7	12	4	1	0	8	0	2.7	2.7	2.0
20 U	5	62	52	84	1	8	3	0	0	6	1	2.8	2.8	2.4
21	12	174	122	70	1	3	12	0	8	5	14	2.9	3.1	2.8
22	5	172	172	100	6	5	0	12	0	4	0	4.0	4.0	4.0
23	7	83	77	93	3	0	0	0	0	2	0	2.3	2.3	2.0
24 U	3	97	53	55	0	3	0	0	0	0	0	1.0	1.0	1.6
25	2	375	350	93	0	6	0	5	0	0	0	3.0	3.0	2.5
26	4	153	150	98	0	10	0	3	0	23	0	3.0	3.5	2.8
27	2	245	205	84	0	6	0	0	0	0	0	3.0	3.0	3.0

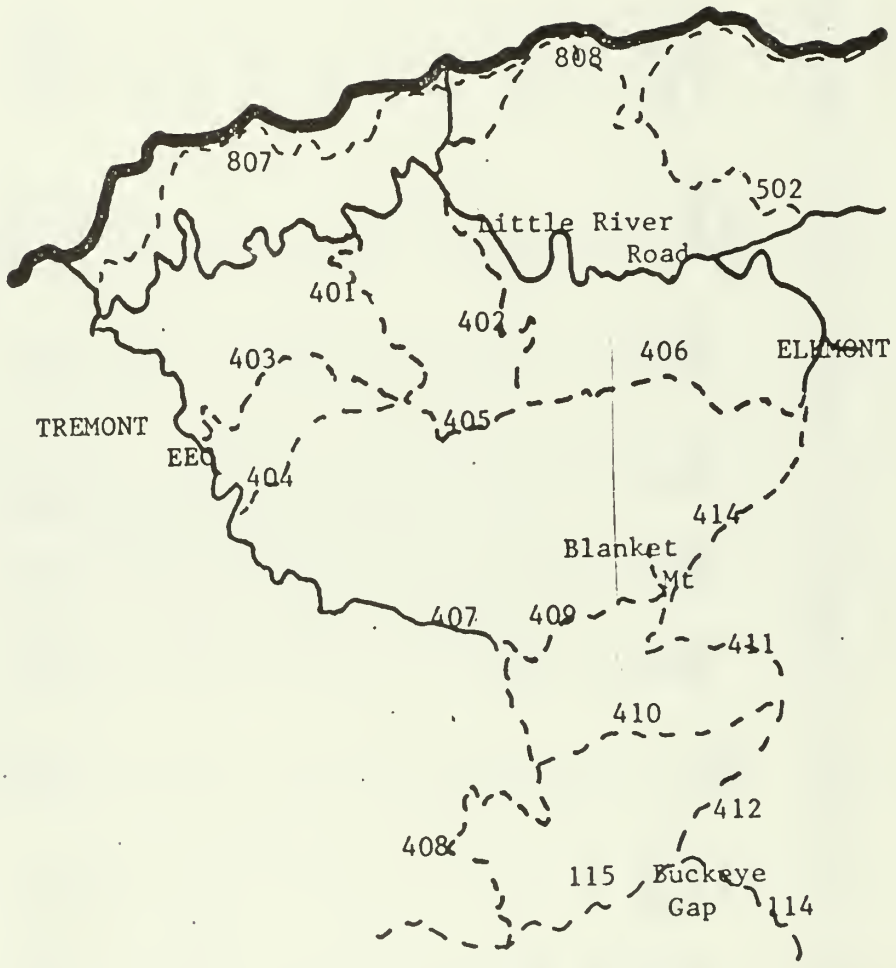
U = Unmaintained

Table Section 3 - Width and Erosion Measurements for Individual Trails - Cades Cove Area - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail o	Mud %	Rut %	Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
28 U	2	50	25	50	0	6	0	0	0	0	0	1.0	1.0	1.5
29	10	253	253	100	1	3	1	0	47	1	1	2.4	2.4	4.4

U = Unmaintained

SECTION 4 - TREMONT



Section 4 - Tremont

Most of the trails in this area are in fair to good condition. Mild water erosion is affecting the surfaces somewhat throughout the area. The trail (409) approaching Jakes Gap from Tremont Road, and the trail to Blanket Mountain (415) both have water erosion and exposed roots. The trail (408) to Derrick Knob also is approaching capacity of use, but has no exceptionally severe problems.

Table Section 4 - Width and Erosion Measurements for Individual Trails - Tremont

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail o	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	9	133	24	18	6	7	1	4	0	10	2	1.9	2.2	2.0
2	9	198	20	10	0	3	0	0	0	0	0	1.0	1.0	2.1
3	12	98	83	85	4	3	0	0	0	2	9	1.8	2.0	2.0
4	6	348	192	55	6	10	3	3	0	19	4	2.0	2.0	3.0
5	4	120	25	21	4	1	0	0	0	1	0	1.3	1.8	1.8
6	7	95	19	20	8	2	0	1	0	2	0	2.0	2.0	1.9
7	9	498	374	75	0	3	0	0	0	0	0	1.4	2.0	2.0
8	13	209	161	77	2	5	1	0	0	0	1	2.8	2.8	2.3
9	6	120	103	86	3	3	4	1	0	4	3	3.0	3.0	2.7
10	10	119	79	66	1	5	0	1	0	0	0	1.9	1.8	2.2
11	6	112	75	67	1	4	1	0	0	4	0	2.2	2.2	1.5
12	8	79	65	82	0	3	1	0	0	4	0	2.1	2.1	2.0
13	3	167	80	48	0	4	0	0	0	0	1	2.6	2.6	2.3

Table Section 4 - Width and Erosion Measurements for Individual Trails - Tremont - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
14	5	432	286	66	0	4	0	0	0	0	3	1.2	1.2	2.0
15	5	212	178	84	2	5	2	0	0	17	6	4.0	4.0	3.6

SECTION 5 - ELKMONT

Section 5 - Elkmont

Most of the problem areas in Elkmont section are in the Chimney Tops area, which is largely spruce-fir forest. The upper end of Goshen Prong trail (578) is water eroded, rutted, and has a problem with exposed roots. The trail to Chimney Tops (523) and the old Indian Gap Road (524) have water erosion, widening, and other typical high elevation, high use problems. The manway from Chimney Tops to Sugarlands Mountain (522) is one of the worst sections of trail in the park. It is muddy and the surface is water eroded with a few exposed tree roots.

Sugarlands Mountain (506, 507), Fish Camp Prong (519), and the recently closed road (520) are the best trails in the section.

Table Section 5 - Width and Erosion Measurements for Individual Trails - Elkmont

Trail No.	N	Tread Width cm	Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
2	15	179	143	80	5	8	0	0	0	2	28	2.1	2.3	3.2
3 U	6	40	0	0	1	11	0	20	0	12	0	2.5	2.8	2.5
4 U	3	133	20	15	7	6	0	8	0	3	0	2.7	3.0	1.7
6	9	123	79	64	0	5	0	0	0	2	2	1.6	1.6	2.0
7	15	118	79	67	1	3	0	0	0	2	0	1.4	1.4	1.7
8	8	130	54	42	2	4	0	1	0	11	0	2.6	2.4	2.1
9	2	180	180	100	18	2	0	90	0	5	25	5.0	4.0	5.0
10	5	164	140	85	1	8	2	20	0	1	1	2.4	2.4	3.2
11 U	2	35	0	0	0	7	10	0	0	0	0	2.0	1.0	3.5
12	7	121	80	66	0	3	0	0	0	4	2	2.4	2.4	1.9
13 U	9	76	73	96	1	6	0	0	0	5	0	2.3	2.4	2.0
14	8	181	98	54	8	7	0	43	0	10	3	2.6	2.8	2.8
15	6	130	117	90	2	6	0	23	0	25	0	2.5	2.5	3.2
16	12	188	96	51	5	4	0	4	0	7	2	2.1	2.2	2.7

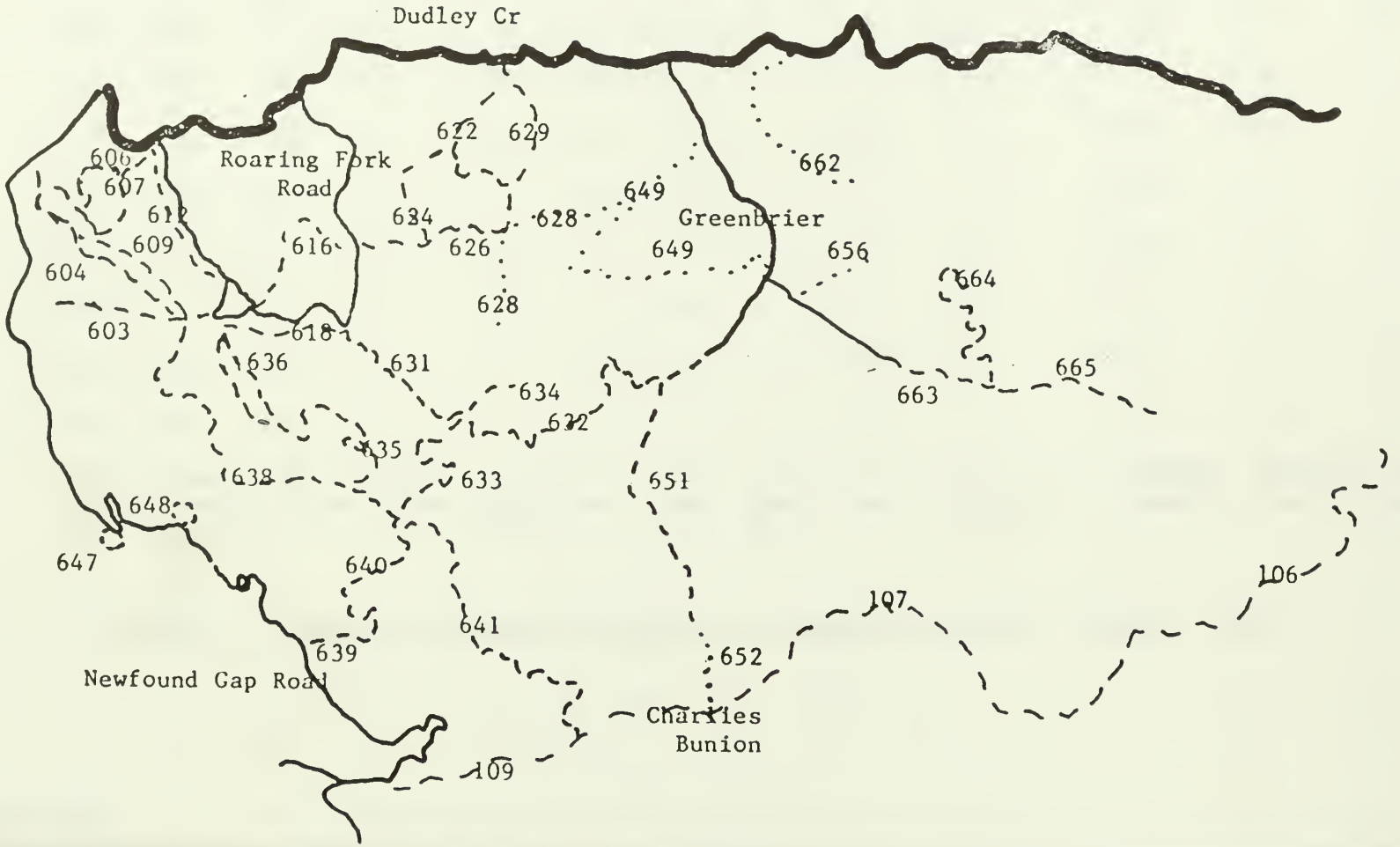
U = Unmaintained

Table Section 5 - Width and Erosion Measurements for Individual Trails - Elkmont - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
17	11	118	91	77	2	1	1	1	0	4	6	1.7	1.0	2.2
18	13	128	88	69	5	4	17	16	0	25	11	2.9	2.9	3.2
19	3	40	3	8	1	2	1	0	0	5	0	1.3	2.0	1.3
20	10	506	416	82	0	2	0	0	0	0	0	2.0	2.0	2.3
21	8	408	143	35	3	1	0	9	0	1	2	2.6	2.4	2.8
22	4	250	200	80	9	15	51	0	0	95	0	5.0	5.0	5.0
23	11	244	203	83	2	6	12	12	0	6	53	2.8	3.1	4.1
24	7	167	163	98	6	7	1	1	0	2	0	3.4	3.4	2.6
25 U	2	140	15	11	0	7	0	33	0	5	3	3.0	3.0	3.5
26	7	187	187	100	0	2	2	0	0	3	6	2.3	3.0	3.0

U = Unmaintained

SECTION 6 - LECONTE



Section 6 - LeConte

The LeConte section is one of the worst in the park and has very few maintained trails in good condition. (Note on the erosion and overall ratings that Jim Graves surveyed most of this section and tended to overrate relative to the other surveyors.)

Both systems of low elevation horse trails, around McCarter's stables and around Dudley Creek, have large percentages of mud, rut, and horse plow and require intensive maintenance. This includes the horse trails (616, 617, and 618) around Roaring Fork Nature Trail.

Upper Trillium Gap trail (633) is muddy and rutted, and the lower end also has problem areas. Both Rainbow Falls foot and Rainbow Falls horse trails (635, 636) have problems with mud, rut, and exposed roots; the horse trail is one of the worst in the park. Alum Cave (639,640) has problems with bank erosion related to heavy use and is down to bedrock. The native trails, Buckeye (648) and Big Locust (647), both are badly rutted and have large areas of exposed roots. The trail to Ramsey Cascades (665) is rutted and has exposed roots and rock.

Most of the remaining trails in the LeConte section, with the exception of some of the manways, are close to carrying capacity in terms of width or depth or are suffering mild surface erosion.

Table Section 6 - Width and Erosion Measurements for Individual Trails - LeConte Area, Maintained

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	4	140	320	229	3	2	4	13	0	0	0	1.8	2.3	2.8
2	2	275	75	27	0	1	7	0	0	0	0	2.0	2.0	4.0
3	3	310	237	76	7	3	0	3	0	0	13	1.0	1.3	2.7
4	4	200	160	80	6	3	34	13	28	0	14	2.0	2.8	3.5
5	10	165	94	57	4	6	12	8	11	3	1	2.0	2.4	2.7
6	5	308	250	81	8	4	47	46	37	0	20	2.6	3.2	4.4
7	10	218	199	91	9	5	59	62	90	1	2	2.8	3.2	4.5
8	9	237	156	66	7	5	29	19	17	5	21	2.6	2.8	3.3
9	6	188	123	65	8	5	31	16	28	0	1	2.5	2.8	3.3
10	2	250	235	67	3	3	25	9	18	0	0	2.5	2.5	4.0
11	4	95	18	19	6	5	0	11	0	5	0	2.5	2.3	1.8
12	2	100	15	15	3	2	0	10	0	28	0	3.0	3.0	2.5
13	2	65	15	23	13	4	0	8	0	4	0	2.0	2.0	2.0
14	3	193	153	79	8	4	0	13	0	33	0	3.0	3.3	3.0

Table Section 6 - Width and Erosion Measurements for Individual Trails - LeConte Area, Maintained - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
16	8	139	93	67	9	6	14	24	9	13	1	2.5	2.5	3.3
17	6	107	80	75	8	7	7	16	3	14	0	2.7	2.5	2.7
18	7	164	109	66	7	4	53	8	18	2	1	2.7	2.9	4.4
19	5	115	124	108	11	7	21	36	14	33	0	3.2	3.0	3.8
22	4	265	218	82	4	5	25	14	18	0	23	2.5	2.8	3.5
23	7	134	90	67	7	5	1	26	0	18	0	2.7	2.6	3.1
24	4	135	115	85	10	10	2	44	2	6	0	3.0	3.0	4.0
26	10	229	209	91	4	4	18	9	12	2	3	2.1	3.0	3.2
27	6	263	243	92	4	4	12	11	8	6	11	2.8	3.0	2.8
28	4	43	3	7	0	6	0	0	0	1	0	1.0	2.3	1.3
29	4	160	148	93	1	8	16	45	16	24	33	3.0	3.3	4.3
30	7	197	135	69	6	7	14	50	13	25	11	2.9	3.0	4.4
31	13	171	132	77	13	6	1	0	1	6	2	2.8	2.9	2.9
32	19	161	77	48	6	4	0	9	0	2	0	2.5	2.4	2.5
33	14	141	99	70	15	6	11	16	10	17	4	2.9	3.1	2.9
35	23	159	134	84	11	7	22	12	16	19	13	3.2	3.3	3.3
36	6	153	133	87	9	11	6	31	0	80	5	3.7	3.8	4.8

Table Section 6 - Width and Erosion Measurements for Individual Trails - LeConte Area, Maintained - Cont,

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
38	25	133	95	71	5	5	0	6	0	7	1	2.1	2.1	2.1
39	10	200	175	88	28	4	1	0	0	12	20	3.3	3.2	3.5
40	8	131	131	100	11	5	0	0	0	15	70	3.1	3.0	4.4
41	19	101	86	85	4	4	4	3	0	16	3	2.2	2.4	2.3
42	4	108	83	77	5	6	1	14	0	29	0	2.8	3.0	2.8
43	6	117	116	99	6	6	1	7	0	5	5	1.8	2.0	2.5
44	2	180	170	94	5	2	0	5	0	3	15	2.0	2.5	2.5
47	4	150	118	79	9	7	0	78	0	68	3	4.0	4.0	5.0
48	4	153	153	100	3	11	0	68	0	30	0	3.0	3.8	5.0
51	11	151	76	50	7	7	0	21	0	22	11	2.6	2.6	2.9
53	4	200	118	59	8	5	0	3	0	3	0	2.0	2.0	2.0
58	2	360	310	86	3	3	0	4	0	0	0	2.0	1.0	2.5
59	2	255	145	57	3	3	0	3	0	0	0	2.0	1.0	5.0
63	5	450	414	92	10	5	0	1	0	0	1	1.6	1.0	2.4

Table Section 6 - Width and Erosion Measurements for Individual Trails - LeConte Area, Maintained - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
67	2	166	160	96	8	7	17	40	8	31	9	3.5	4.0	5.0
68	10	113	97	86	25	17	7	5	0	48	7	3.7	4.0	3.7
65	9	133	124	93	8	9	2	56	0	72	0	3.8	3.6	4.7

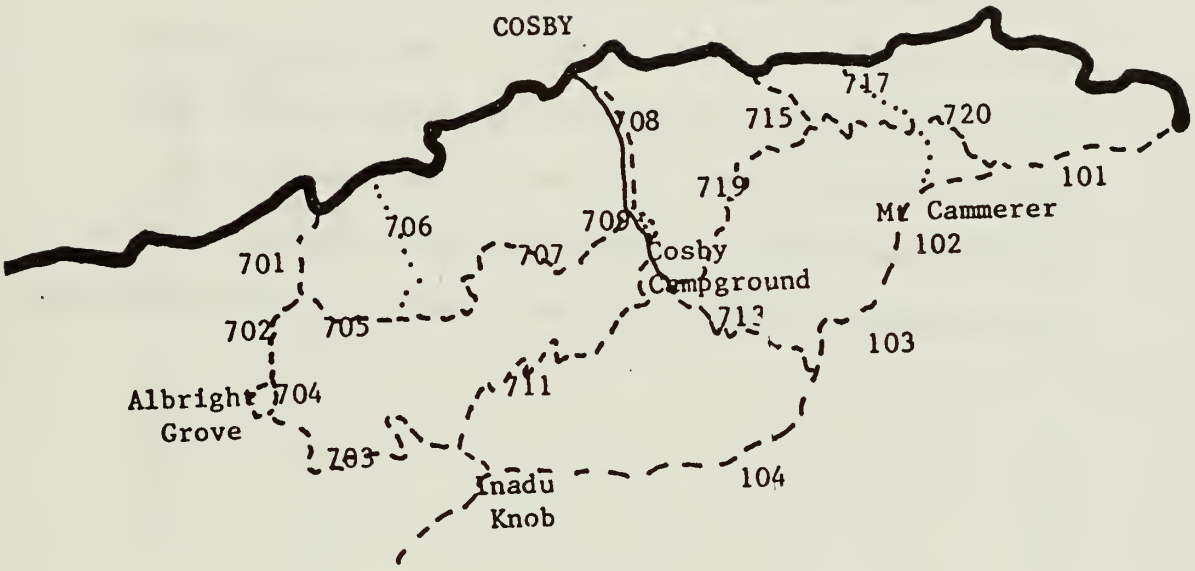
Table Section 6 - Width and Erosion Measurements for Individual Trails - LeConte Area, Unmaintained

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
15	5	110	76	69	7	5	6	39	0	6	0	2.4	3.0	3.6
20	2	130	0	0	5	7	0	0	0	0	0	2.5	3.0	4.5
21	4	38	13	34	4	4	0	13	0	6	0	2.0	2.5	2.0
25	3	100	0	0	12	3	0	13	0	0	0	2.3	1.7	2.3
28	4	43	3	7	0	6	0	0	0	1	0	1.0	2.3	1.3
37	8	65	34	52	11	17	0	14	0	34	0	2.9	3.3	3.1
45	2	40	0	0	13	5	0	25	0	63	0	3.0	3.5	4.0
46	2	135	60	44	13	5	3	65	0	70	35	5.0	4.5	5.0
49	16	138	28	20	9	7	1	26	0	3	4	2.6	2.9	3.1
52	9	88	62	70	6	21	0	55	0	54	0	3.8	3.0	4.3
54	2	185	0	0	0	0	0	0	0	10	0	2.0	2.0	2.5
55	5	62	12	19	1	5	0	11	0	9	0	2.2	2.0	1.6
56	3	33	0	0	0	6	0	5	0	10	0	2.7	2.7	1.7
57	2	35	0	0	0	10	0	2	0	5	0	1.5	1.5	1.0

Table Section 6 - Width and Erosion Measurements for Individual Trails - LeConte Area, Unmaintained - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
60	2	25	10	40	0	5	3	0	0	20	0	2.5	3.5	2.0
61	2	30	0	0	3	15	0	1	0	2	0	1.0	3.0	1.0
62	4	90	5	0	10	5	0	19	0	2	9	2.8	2.8	2.8
66	2	40	5	13	5	11	0	50	0	95	0	3.5	4.0	5.0

SECTION 7 - COSBY



Section 7 - Cosby

Cosby, like LeConte, tends to be in fair to poor condition. The trail through Albright Grove (704) has moderate problems with rut and tree roots, as does Maddron Bald Trail (703). The trail (707) from Henwallow Falls to Cosby Campground has surface erosion, bank erosion, and exposed roots. The trail from Inadu Knob to Cosby (711) has ruts and exposed roots. The trail near Inadu is in spruce-fir and is erosion sensitive. The low elevation horse trails have problems with mud and rutting.

Table Section 7 - Width and Erosion Measurements for Individual Trails - Cosby

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail o	Mud %	Rut %	Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	7	316	301	95	2	5	0	4	0	0	0	1.7	1.9	2.7
2	4	110	80	73	3	4	0	5	0	23	0	2.8	2.8	2.3
3	12	83	45	54	3	5	3	17	0	18	1	2.6	2.5	2.5
4	5	76	52	68	4	6	0	27	0	31	0	2.8	2.8	3.0
5	7	66	50	76	2	6	0	14	0	46	0	2.4	2.4	3.0
6 U	7	119	124	104	4	6	0	23	0	4	0	2.3	2.6	2.4
7	10	98	66	67	7	6	12	0	0	12	44	2.0	2.3	3.5
8	12	126	86	68	3	4	0	16	0	6	0	2.6	2.5	2.6
9	4	315	255	81	10	5	0	11	0	0	0	2.3	2.3	2.3
10	6	163	128	79	5	5	0	53	0	26	0	3.7	3.8	4.5
11	21	173	148	86	5	7	3	18	1	20	3	2.7	2.6	3.0
12	2	385	360	94	3	5	0	3	0	3	0	1.5	1.0	2.5
13	8	208	184	88	4	9	3	6	1	16	18	2.4	2.5	2.6
14	2	115	110	96	5	8	5	43	8	30	0	3.0	3.0	4.0

U = Unmaintained

Table Section 7 - Width and Erosion Measurements for Individual Trails - Cosby - Cont.

Trail No.	N	Tread Width cm	Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
15	4	233	35	15	13	4	0	0	0	3	16	2.5	2.8	3.8
16	2	365	365	100	10	2	0	0	0	0	0	2.0	2.0	3.0
17 U	9	76	10	131	4	6	0	23	0	4	0	2.3	2.6	2.4
18	2	85	35	41	8	9	0	8	0	14	0	3.0	3.0	1.5
19	8	144	108	75	6	4	0	0	0	1	15	1.9	2.0	3.0
20	11	102	55	54	7	3	0	0	0	13	16	1.8	2.1	2.1
21	2	65	30	46	3	13	0	0	0	20	0	2.0	2.0	2.0
22	5	142	130	92	6	5	1	34	0	8	0	2.6	3.4	3.2
23	5	116	90	78	5	5	3	0	2	6	9	2.4	2.8	2.8

U = Unmaintained

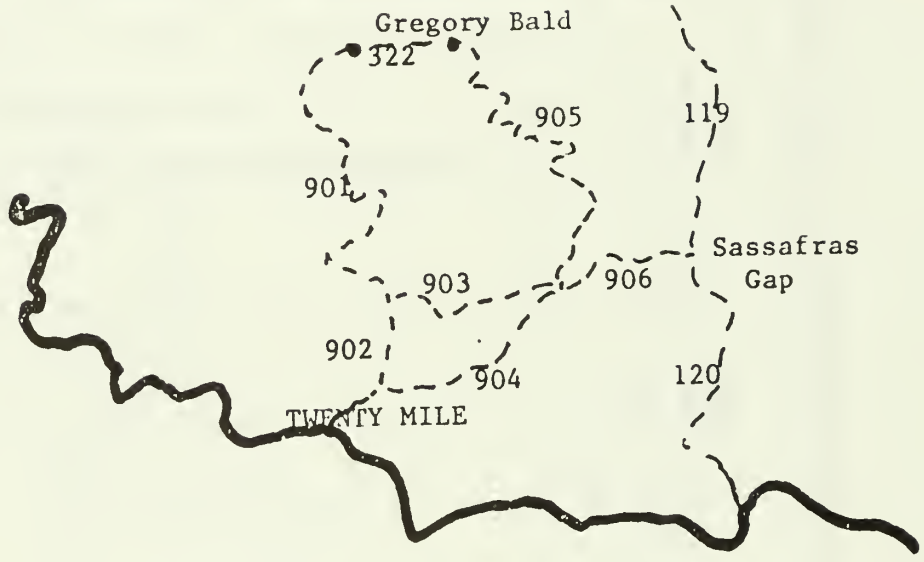
SECTION 8 - BOUNDARY TRAIL

Section 8 - The Boundary Trail

The Boundary Trail is in good condition throughout. Bank erosion is the only major problem, and it is worst near Rich Mountain Tower (804). There are some ruts and exposed roots in the Cove Mountain area (809), with these two sections probably the only ones near carrying capacity.

Table Section 8 - Width and Erosion Measurements for Individual Trails - Boundary Trail

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	11	106	41	39	1	3	0	0	0	0	1	1.0	1.0	1.0
2	12	138	51	37	2	2	0	0	0	0	3	1.3	1.2	1.6
3	9	111	48	43	4	3	0	0	5	1	4	1.4	2.0	1.8
4	5	220	184	84	1	1	0	3	3	0	60	2.8	2.8	3.8
5	14	64	18	28	2	4	0	0	0	0	22	1.7	1.2	2.1
6	16	106	39	37	3	3	0	8	1	0	12	1.9	1.6	2.6
7	24	104	35	34	3	3	21	0	0	0	6	1.2	1.1	1.8
8	13	88	25	28	4	4	0	0	0	0	0	1.5	1.2	1.7
9	29	175	31	18	1	5	2	26	0	4	12	2.0	2.0	3.2


Gregory Bald
322
905
119
901
Sassafras
Gap
903
906
902
904
120
TWENTY MILE

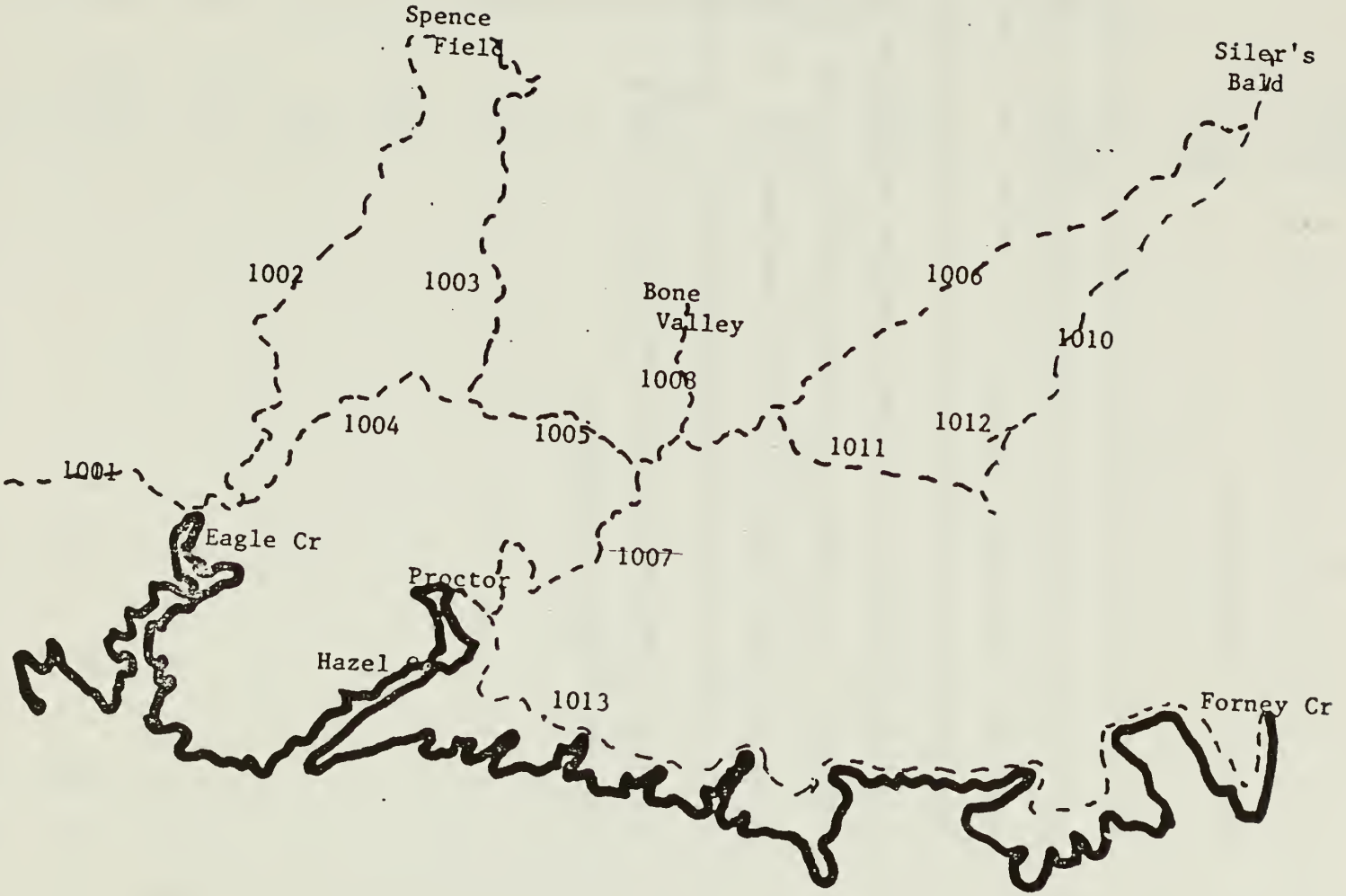
Section 9 - Twenty Mile

The only trail in the Twenty Mile area with really severe erosion problems is 906, the former jeep road to Shuckstack Firetower. The surface is water eroded and rutted. Careful attempts to keep up with water erosion in this section should keep most of the trails in good condition.

Table Section 9 - Width and Erosion Measurements for Individual Trails - Twenty Mile

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	14	139	46	33	0	4	0	0	0	0	0	1.1	1.1	1.7
2	6	308	118	38	4	1	2	1	0	1	0	2.0	1.8	2.5
3	10	94	28	30	1	2	0	0	0	0	0	1.5	1.0	1.2
4	9	408	234	57	2	3	0	1	0	0	0	2.6	2.6	3.1
5	13	177	52	29	0	5	1	1	0	1	0	1.5	1.5	2.5
6	7	209	143	68	8	3	1	16	0	0	6	3.3	2.9	3.4
7	8	285	53	19	0	3	0	0	0	0	0	1.9	1.9	2.0

SECTION 10 - HAZEL CREEK



Section 10 - Hazel Creek

Section 10 is also in good-to-fair condition. The worst trail in the area is the former jeep road (1011) from Hazel Creek to High Rocks. The trail is water eroded, rutted, muddy, and has much exposed rock. The creek runs in the trail, implying that proper maintenance in its present position on the slope may be impossible. The upper end of Hazel Creek Trail (1006) is very steep and already has problems with water erosion. The Lake Trail (1013) is in generally good condition, but some stretches are badly routed and need to be moved before a trail cut is made and traffic is increased.

Table Section 10 - Width and Erosion Measurements for Individual Trails - Hazel Creek

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	12	182	55	30	0	6	3	0	0	3	4	1.7	1.7	2.2
2	21	182	61	34	0	3	1	0	0	2	0	1.3	1.3	2.5
3	15	91	43	47	1	6	1	0	0	4	0	1.7	1.4	2.1
4	11	386	79	20	0	1	15	0	0	0	27	1.1	1.0	3.0
5	10	373	86	23	2	3	0	1	0	0	0	2.6	2.0	2.6
6	27	263	135	51	4	3	5	7	0	10	2	2.4	2.4	2.4
7	13	389	205	53	0	1	0	0	0	0	2	2.0	2.2	2.0
8	7	379	73	19	3	2	6	8	0	0	1	1.9	1.9	2.4
9	10	132	98	74	5	3	3	9	0	18	22	2.6	2.5	2.5
10	17	114	70	61	4	2	0	5	3	7	12	2.5	2.3	2.4
11	12	225	162	72	12	6	8	34	8	8	13	3.9	3.8	4.3
12	3	213	63	30	1	7	1	0	5	6	1	2.0	2.0	2.0
13 U	59	90	16	18	0	5	0	2	0	0	6	1.2	1.2	1.7

U = Unmaintained

SECTION 11 - FORNEY CREEK

Section 11 - Forney Creek

Forney Creek section has several problem areas. The trail to Andrews Bald (the upper end of 1104) is one of the worst in the park. It is deeply rutted and has mudholes and exposed roots. It is also badly widened in places. Conditions improve below the bald but there is still some water erosion. Forney Creek Trail (1102) is also water-eroded at the upper end. The horse trail cutoffs are steep in places and, although new, are developing local problems with rut and mud. The upper end of Noland Creek Trail (1109) is very muddy and there are problems with drainage. The Lake Trail (1112) is generally in good condition, but there are local problems with horse plow and water erosion, especially near Forney Creek. The horse cutoff (113) is rutting on steeper slopes. The trail to High Rocks (1101) has problems with rut and horse plow, particularly at the steep upper end.

Table Section 11 - Width and Erosion Measurements for Individual Trails - Forney Creek

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	19	310	99	32	3	6	2	7	8	0	24	2.7	2.7	3.0
2	25	110	76	69	4	3	4	13	0	13	10	2.8	3.2	2.7
3	11	392	111	28	0	1	2	0	0	1	1	2.2	2.2	2.2
4	24	127	80	63	9	2	3	37	0	14	5	3.1	3.0	3.0
5	13	158	55	35	1	3	1	0	0	2	3	1.4	1.4	2.1
8	10	151	113	75	6	3	2	4	0	2	2	2.3	1.8	1.9
9	16	312	148	47	5	4	35	2	0	3	1	2.9	2.9	2.9
10	16	411	232	56	1	2	1	0	0	0	1	2.0	2.1	2.1
11	13	92	55	60	5	4	2	0	2	1	8	2.1	2.0	2.0
12	18	124	79	64	4	7	3	5	37	2	7	2.4	2.3	2.7
13	7	67	67	100	6	7	0	9	0	2	12	2.9	2.1	2.9
14	2	200	200	100	5	3	0	0	0	0	0	3.0	3.0	3.0
16	3	175	175	100	8	6	0	13	0	5	8	5.0	5.0	5.0

SECTION 12 - DEEP CREEK

Section 12 - Deep Creek

Many of the trails in Deep Creek section are in good condition, although Deep Creek Trail itself (1202, 1203, 1204) is having problems with water erosion, mud, and exposed roots. The trail through Cooper Creek drainage (1218) is also having problems with water causing rut and mud, as is Mingus Creek Trail (1220). The unfinished motor nature trail (1227) has bank erosion and is beginning to slump in a few places.

Table Section 12 - Width and Erosion Measurements for Individual Trails - Deep Creek

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	7	636	451	71	0	2	0	0	0	0	11	2.0	2.0	2.1
2	12	224	176	79	6	4	4	0	3	4	20	3.5	3.5	3.8
3	12	193	98	51	5	2	11	0	6	4	1	3.8	3.8	3.3
4	11	149	87	58	1	4	4	0	0	10	5	2.8	2.8	2.5
5	9	166	62	37	2	4	1	0	0	2	1	1.1	1.1	2.0
6	14	79	33	42	0	4	3	1	0	19	3	3.0	2.9	2.0
7	20	103	40	39	2	4	0	2	1	1	4	1.7	1.4	1.6
8	13	113	65	58	3	4	19	15	0	27	2	2.6	2.2	2.9
9	3	353	230	65	5	4	0	3	0	0	2	2.7	2.0	2.7
10	10	501	288	57	1	2	0	0	0	0	5	2.1	2.0	2.0
11 U	13	72	15	21	0	3	0	0	0	0	2	1.1	1.0	1.0
12	9	124	26	21	0	4	0	10	0	2	1	1.4	1.3	1.9
13	14	70	47	67	0	2	0	1	0	1	0	1.5	1.3	1.4

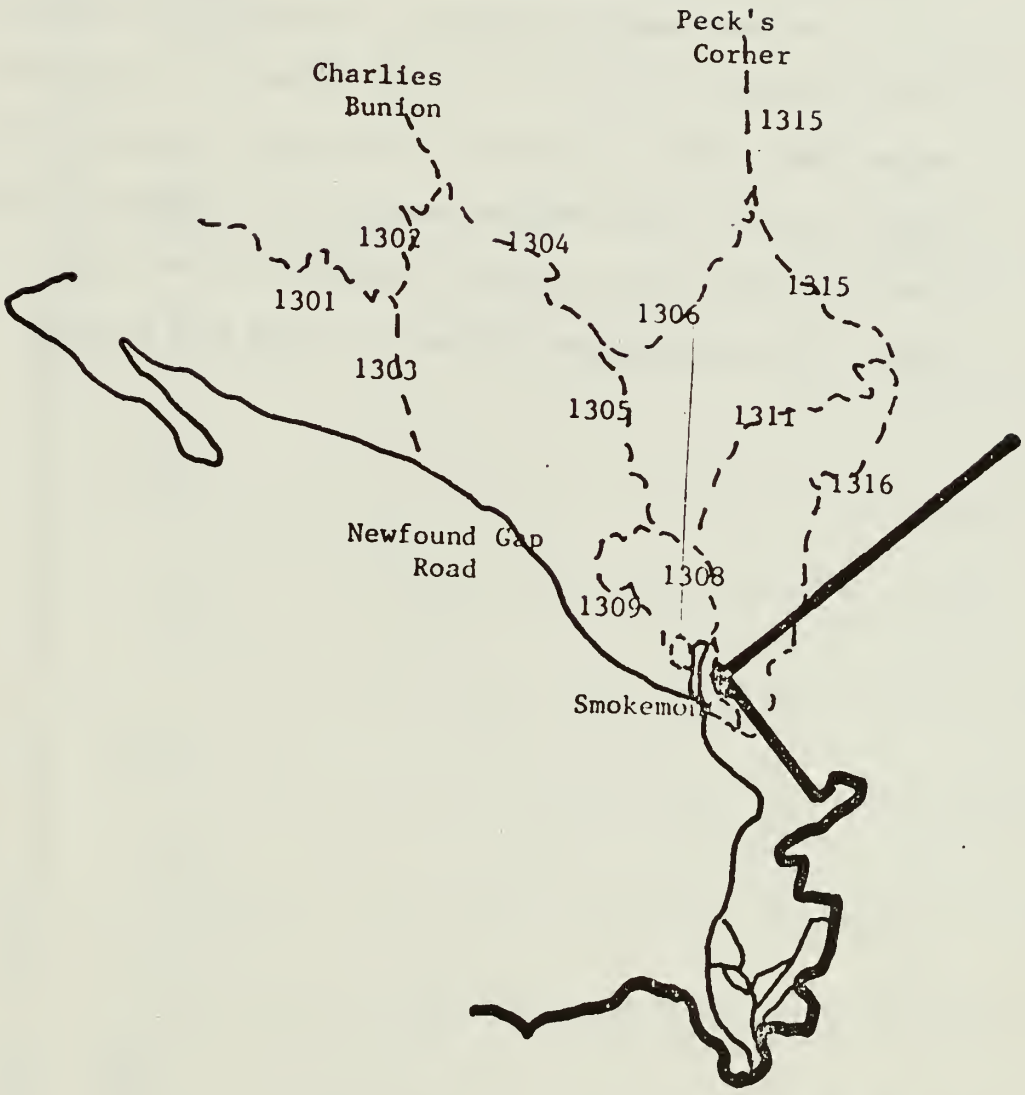
U = Unmaintained

Table Section 12 - Width and Erosion Measurements for Individual Trails - Deep Creek - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
14	6	62	40	65	0	2	0	0	0	1	0	1.0	1.5	1.2
15	5	41	18	44	0	4	0	0	0	2	0	1.4	1.4	1.4
16	8	50	8	16	0	2	0	0	0	1	1	1.1	1.0	1.0
17 U	14	89	12	13	0	5	2	0	0	0	1	1.4	1.4	1.6
18	8	174	73	42	0	6	11	36	0	6	1	3.1	2.4	3.8
19	12	149	50	34	0	4	6	0	0	0	6	2.5	2.4	2.5
20	9	256	94	37	1	5	11	1	0	0	0	3.0	3.1	3.1
21	9	74	0	0	0	3	0	0	0	0	0	1.0	1.0	1.3
22	8	51	17	33	0	4	0	0	0	0	0	1.4	1.5	1.4
23	14	56	26	46	0	2	2	0	0	0	0	1.6	1.6	1.3
24 U	4	208	23	11	2	3	0	4	0	0	6	1.5	1.5	3.0
27	15	379	262	69	0	4	2	5	0	0	25	2.5	2.3	2.6
28	12	153	118	77	4	5	0	4	4	0	7	2.4	2.3	2.3

U = Unmaintained

SECTION 13 - SMOKEMONT



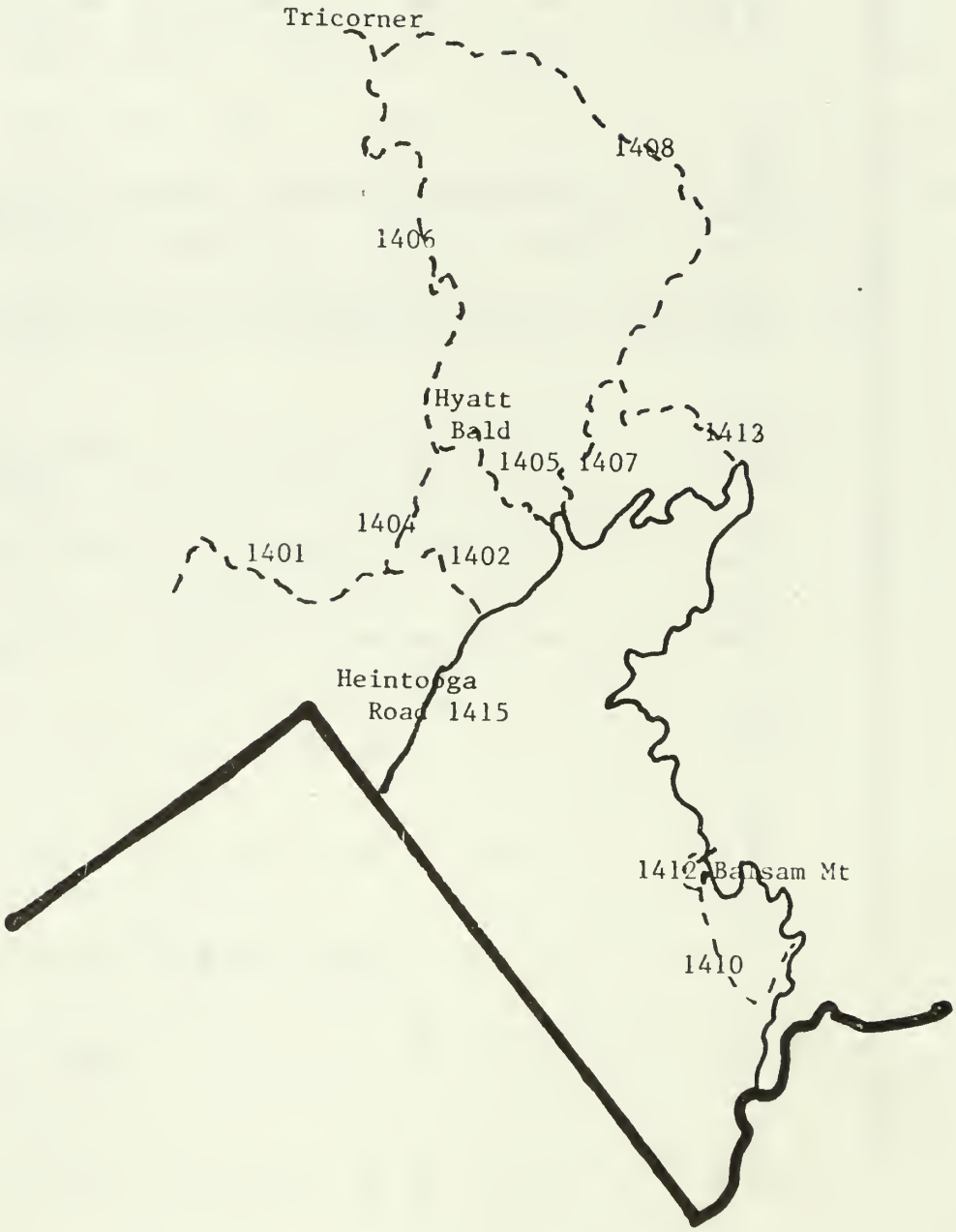
Section 13 - Smokemont

The Smokemont section tends to have erosion problems in the steeper sections near the ridge tops. Richland Mountain Trail (1304) has water erosion and rutting, as does the upper end of Tawaha Creek (1306). A section of the trail to Kephart Shelter (1303) is water eroded and has exposed rock. Some of the lower elevation trails which are used primarily by horses (1312, 1313, 1314) have problems with mud, rut, and bank erosion.

Table Section 13 - Width and Erosion Measurements for Individual Trails - Smokemont

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	11	84	66	79	5	3	0	3	0	10	5	1.0	2.0	1.9
2	6	77	73	95	2	4	1	3	0	1	10	2.2	2.0	2.2
3	6	256	198	77	2	3	2	6	0	1	2	2.3	2.3	2.3
4	15	129	108	84	6	4	2	22	5	8	5	3.3	3.3	3.3
5	7	346	68	0	2	0	0	0	0	0	2	2.0	2.0	2.1
6	11	325	277	85	5	7	0	5	2	3	5	2.8	2.5	2.8
7	4	210	172	82	0	1	0	1	0	0	4	2.0	2.0	2.7
8	6	352	340	97	0	1	0	1	0	0	4	2.2	2.0	2.5
9	11	114	91	80	1	5	0	0	0	5	4	1.4	1.1	1.4
10	4	65	45	69	0	3	0	0	0	4	0	1.2	1.2	2.0
11	7	367	307	84	2	3	0	2	0	0	4	2.3	2.1	2.3
12	3	113	93	82	0	1	0	3	0	13	23	3.0	3.0	2.0
13	7	234	207	88	6	4	15	53	61	0	36	4.3	4.3	5.0
14	5	110	66	60	0	3	2	4	6	7	18	2.8	2.8	2.0
15	13	144	125	87	4	4	0	5	1	9	3	2.3	2.1	2.4
16	19	90	69	77	5	3	0	9	7	3	1	1.7	1.6	2.1

SECTION 14 - HEINTOOGA

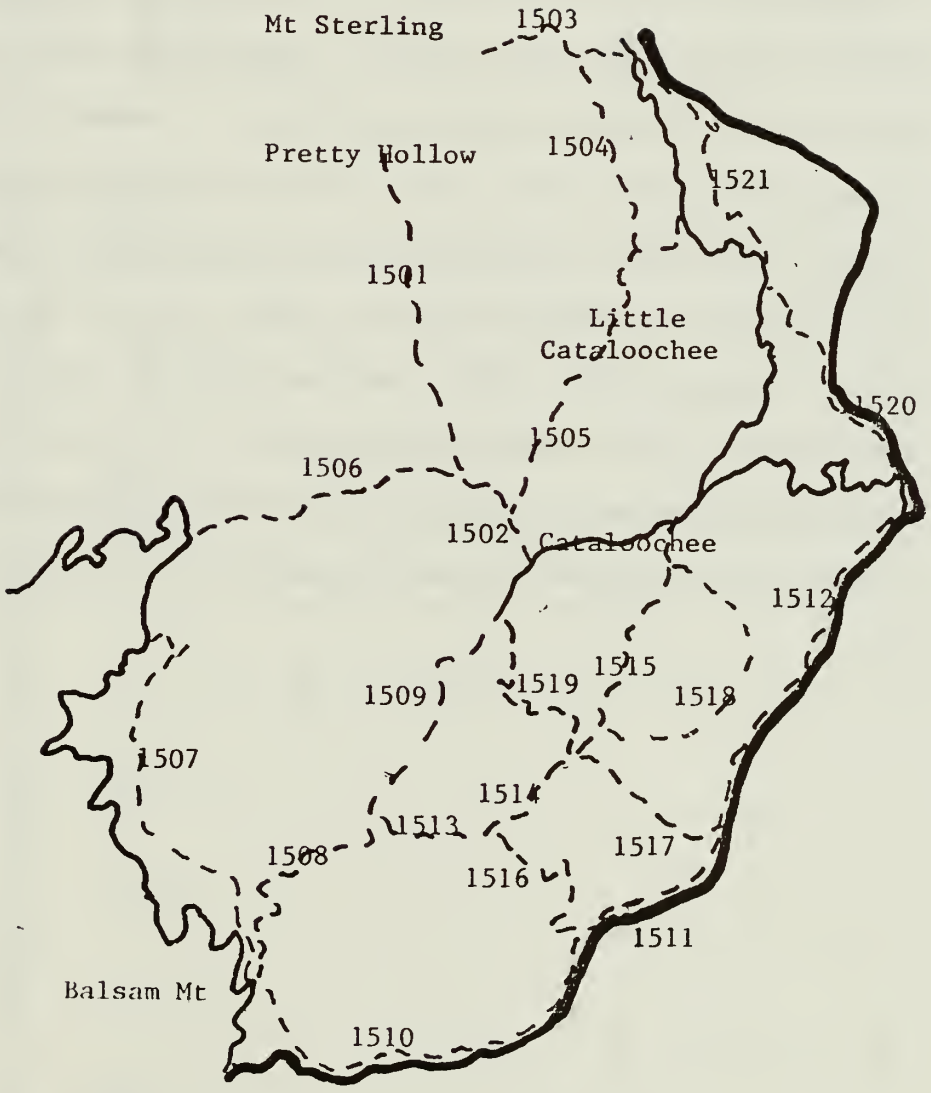


Section 14 - Heintooga

Heintooga section has a large area of spruce-fir forest which influences conditions even on moderately used trails. The trail from Tricorner to Hyatt Bald (1406) is the worst of the longer trails in the section. It has large amounts of mud, rut, and tree roots, especially in the sections that run along the ridge top. Balsam Mountain (1408) also has local areas of mud, rut, and roots. Both trails should be considered difficult to maintain. The jeep trail from Heintooga Road to Hyatt Ridge (1402) is water eroded and has much bare rock. The short trails near Balsam Mountain Campground are erosion sensitive and rutted on the steeper sections.

Table Section 14 - Width and Erosion Measurements for Individual Trails - Heintooga

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	12	92	77	84	2	4	2	2	2	6	3	1.9	1.8	2.1
2	8	184	184	100	1	5	0	0	2	2	25	3.4	3.5	3.1
4	6	285	197	69	0	4	6	0	0	7	0	2.5	2.5	2.5
5	9	90	63	70	0	4	3	1	1	7	2	2.0	2.0	1.5
6	16	162	139	86	2	3	31	13	12	23	8	3.4	3.3	3.7
7	10	162	100	62	0	4	1	10	0	13	21	2.8	2.8	2.5
8	16	67	61	91	0	2	2	7	0	30	5	3.1	3.1	2.6
9	7	183	138	75	0	3	3	14	0	11	12	2.6	2.6	2.6
10	11	174	65	37	3	3	1	2	0	8	0	2.0	2.0	2.4
11	2	265	265	100	0	41	80	0	0	77	0	5.0	5.0	5.0
12	4	167	87	52	0	3	2	0	0	52	1	4.0	4.0	4.2
15	36	473	368	78	0	2	0	0	0	0	9	2.2	2.0	2.5


Mt Sterling
1503
Pretty Hollow
1504
1521
1501
Little
Cataloochee
1520
1505
1506
1502
Cataloochee
1512
1515
1509
1519
1518
1507
1514
1513
1517
1508
1516
1511
Balsam Mt
1510

Section 15 - Cataloochee

A substantial portion of the trails in Cataloochee area have problems with mud and horse plowing. Probably the worst is the middle section of Cataloochee Divide (1511). A number of others, including 1516, 1513, 1515, 1519, 1501, and 1506 fall into this category. The trail to Spruce Mountain Tower (1507) has both typical spruce-fir problems with mud, roots, and rut, and evidence of horse damage, as does 1508. Only two of the 21 trails in this section had all their erosion ratings above 3.0. Of the sections on the North Carolina side of the park, Cataloochee has the most problem trails and needs the most attention from management.

Table Section 15 - Width and Erosion Measurements for Individual Trails - Cataloochee

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	10	161	101	63	4	5	18	2	3	6	0	3.7	3.7	3.1
2	5	328	246	75	2	1	103	0	5	0	0	3.0	3.0	3.2
3	7	261	199	76	4	6	2	1	2	2	7	3.6	3.6	2.4
4	14	166	95	57	8	5	15	1	20	3	1	2.7	2.4	2.7
5	16	294	200	68	5	5	35	9	35	8	1	3.3	3.0	3.3
6	13	126	84	67	6	3	15	6	23	5	8	3.2	3.3	3.0
7	24	153	123	80	10	4	5	32	4	17	1	3.8	3.9	3.8
8	9	257	122	56	4	3	1	0	5	3	5	3.2	3.2	2.3
9	9	261	146	56	1	4	6	0	22	0	6	3.4	3.4	3.3
10	19	158	78	49	10	3	15	19	29	4	6	3.0	2.5	2.7
11	6	217	122	56	7	5	63	68	90	3	0	4.3	4.5	4.8
12	14	105	42	40	2	3	0	3	4	0	2	1.6	1.3	1.5
13	4	168	100	60	6	3	16	1	36	7	0	4.0	4.0	3.5
14	5	244	154	63	3	1	5	2	8	1	0	2.8	2.8	3.0

Table Section 15 - Width and Erosion Measurements for Individual Trails - Cataloochee - Cont.

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Rating	Computer Erosion Rating
15	8	244	116	48	2	1	37	11	20	6	0	4.1	4.1	3.8
16	8	175	164	94	6	4	27	6	65	0	1	3.9	3.9	4.5
17	8	198	114	58	4	8	3	17	4	0	0	3.0	3.0	3.0
19	10	206	113	55	61	3	11	0	15	0	9	3.4	3.4	3.2
20	24	83	16	19	2	5	4	2	0	1	1	1.3	1.3	1.5
21	4	273	228	84	10	4	4	11	0	0	0	3.3	3.0	3.3

SECTION 16 - BIG CREEK

Section 16 - Big Creek

The most eroded trail in the Big Creek area is the trail between Mount Sterling and Pretty Hollow Gap (1607), which has uncontrolled water erosion, mud, and exposed roots. The trail to Low Gap (1603) and Swallow Fork Trail (1605) both are water eroded, and Swallow Fork has a number of mudholes.

Table Section 16 - Width and Erosion Measurements for Individual Trails - Big Creek

Trail No.	N	Width cm	Tread Width cm	Tread %	Depth cm	Slope Trail °	Mud %	Rut %	Horse Plow %	Roots %	Side Erosion %	Erosion Rating	Overall Rating	Computer Erosion Rating
1	17	145	83	57	2	2	0	1	0	1	5	2.2	2.0	2.1
2	12	158	70	44	1	5	1	0	0	2	8	2.0	2.0	2.6
3	12	156	136	87	9	5	0	0	2	11	11	3.2	2.9	3.3
4	18	413	284	69	0	1	0	0	4	1	2	2.1	2.1	2.5
5	11	286	124	53	3	5	4	6	2	4	19	3.1	3.1	3.4
6	11	211	95	45	3	3	16	11	5	2	6	2.8	2.9	3.7
7	5	208	158	76	5	4	4	0	1	12	1	4.4	4.4	4.6
8	23	121	80	66	1	4	2	2	0	14	3	2.6	2.7	2.5